Editorial Staff
New York
V. T. Boughton
W. G. Bowman
C. S. Hill
F. W. Herring
H. W. Richardson

Engineering News-Record

A Consolidation of Engineering News, Engineering Record
The Sanitary Engineer, and The Contractor

F. E. SCHMITT, *Editor*

Editorial Staff
Chicago
W. W. De Berard
San Francisco
N. A. Bowers
J. I. Ballard

Willard Chevalier
Publishing Director

◆

Contents for October 27, 1932

VOLUME 109, NUMBER 17

Copyright, 1932, by McGraw-Hill Publishing Company, Inc.

Airship Dock Erection by Tall Timber Traveler........... 487

Pedestrian Tunnels Provide Jobs in San Diego............ 490
BY THEODORE E. KENNY

Wood Floor Design for Masonry Wall Buildings.......... 491
BY NORMAN B. GREEN

The Supply Dealer's Place in Materials Distribution........ 493
BY O. FRED ROST

Parabolic Vertical Curves for Highway Grades............ 496
BY M. W. FURR

Replacing Plate-Girder Spans by Inverting............... 497
BY T. KURODA

Thin Concrete Diaphragm Protects Ringedal Dam........ 498
BY CHR. F. GRÖNER

Grand Trunk Railway Relocation at Detroit.............. 501

Effluent of Eight-Year-Old Sewage Plant in Illinois........ 504

Letters..........505 Editorials..........508 News..........510

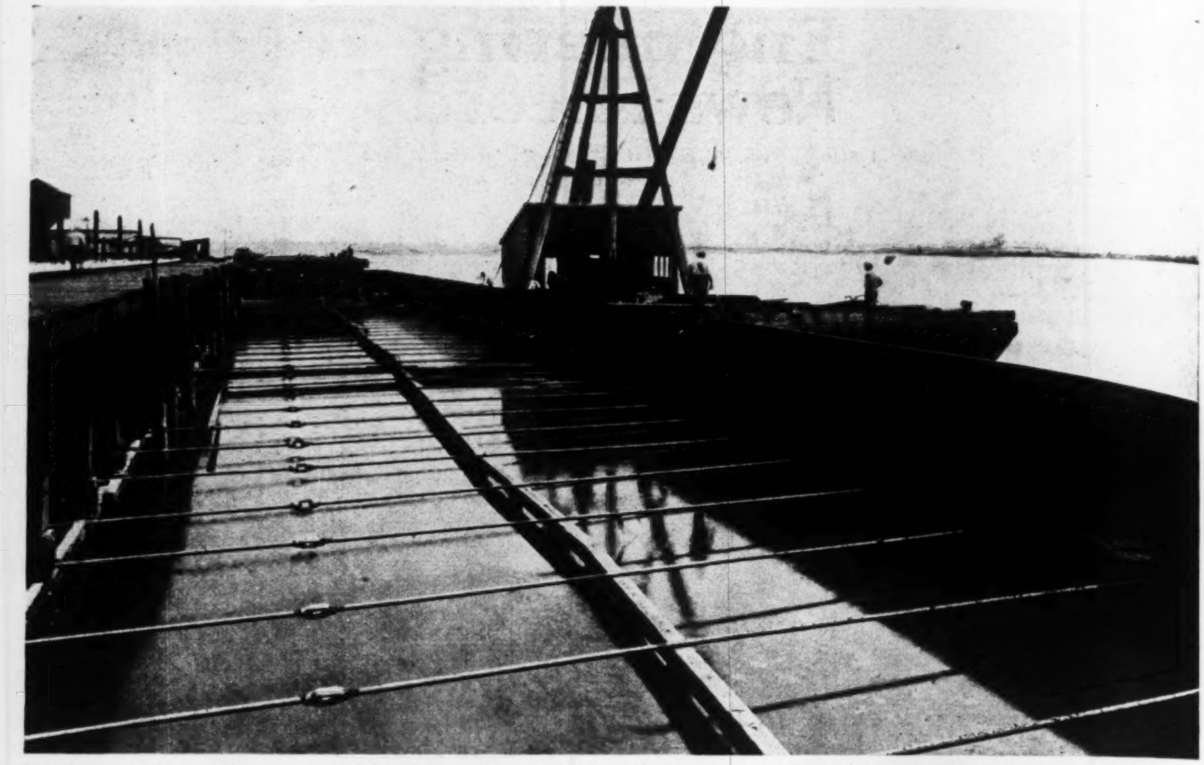
Equipment..........515 Unit Prices..........516

◆

Published every Thursday. Price 25c. per copy. Subscription, domestic, Central and South America, $5 per year. Canada, including duty, $7.50. Foreign $9 or 45 shillings. Entered as second-class matter at the Post Office at New York, N. Y., under the Act of March 3, 1879. Printed in U. S. A. Cable Address "MCGRAWHILL, New York." Member A.B.P. Member A.B.C.

McGRAW-HILL PUBLISHING COMPANY, INC., 330 WEST 42d STREET, NEW YORK, N. Y.

Editorial and Publishing Offices: 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, W. C. 2, England. Branch Offices: Washington; Philadelphia; Cleveland; Detroit; St. Louis; Boston; Greenville, S. C.; Los Angeles. James H. McGraw, Chairman of the Board; Malcolm Muir, President; James H. McGraw, Jr., Vice-President and Treasurer; Mason Britton, Vice-President; Edgar Kobak, Vice-President; H. C. Parmelee, Vice-President and Editorial Director; Harold W. McGraw, Vice-President; C. H. Thompson, Secretary.



Showing one piling wall and, at the left, the old wooden wharf which the new 60-ft.-wide pier replaces. Bethlehem (Lackawanna) Deep Arch Section DP 165 in lengths of from 30 to 40 ft. was used on this job.

HARD GRAVEL--BOULDERS

proved no obstacle to

BETHLEHEM (Lackawanna) PILING

When it was decided to build a new pier at Station B of the Philadelphia Gas Works Company, difficulty was anticipated because of the hard gravel bed of the Delaware River at that point, and careful study was given to the selection of the piling.

The decision to use a steel sheet piling structure was based largely on the results of driving test piles. While the timber piles that were tested could not be driven to the required depth because of their tendency to "broom" and splinter, Bethlehem (Lackawanna) Steel Sheet Piles were driven in the hard river bed to the required penetration.

The use of Bethlehem (Lackawanna) Piling was fully justified by the results obtained. The entire 425 tons of piling required for the job were driven without difficulty; only two boulders were encountered which the piling was unable to split, and they were readily rolled out from beneath the piling by dredging. Further, using Bethlehem (Lackawanna) Piling instead of following the type of construction originally contemplated resulted in a very substantial saving.

If you are planning a job that involves the retaining of earth or water, either in permanent or temporary work, perhaps the use of Bethlehem (Lackawanna) Piling would help to simplify your problem and to lower the cost of the project.

The completed pier, built at Station B of the Philadelphia Gas Works Company.

Kolyn Construction Company, Contractor.

KALMAN STEEL CORPORATION

Subsidiary of Bethlehem Steel Corporation

General Offices: BETHLEHEM, PA.

District Offices: **Albany, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cleveland, Cincinnati, Detroit, Houston, Milwaukee, Minneapolis, New York, Philadelphia, Pittsburgh, St. Louis, St. Paul, Syracuse, Washington.** ***Pacific Coast Distributor:*** **Pacific Coast Steel Corporation, San Francisco, Los Angeles, Seattle, Portland, Honolulu.** ***Export Distributor:*** **Bethlehem Steel Export Corporation, New York.**

Engineering News-Record

Vol. 109 New York, October 27, 1932 **No. 17**

Sunnyvale Airship Dock..............487
Pedestrian Tunnels at San Diego......490
Wood Floors in Masonry Buildings...491
The Materials Supply Dealer..........493
Parabolic Vertical Highway Curves....496
Novel Girder Replacement............497
Ringedal Dam in Norway............498
Grand Trunk Railway Relocation.....501
Operations at Urbana Sewage Plant...504
Letters to the Editor.................505
Editorials 508
News of the Week 510
Equipment and Materials 515
Unit Prices 516

◆

Timber Traveler Erects Airship Dock

Carrying three stiff-leg derricks, traveler 194 ft. high erects each arch truss and its bracing in Sunnyvale hangar in 3½ days—Moved 72 ft. to position of next arch in 2 min.

A TIMBER TRAVELER 194 ft. high, carrying three 35-ton stiff-leg derricks, accounted for unusual but most successful erection procedure on the steel framework of the huge airship dock at the Pacific Coast naval airbase at Sunnyvale, Calif. The traveler was typically Western in its extensive use of timber framing, which totaled 350,000 ft. b.m. and was a distinct departure from the type of equipment previously used on work of this character. Mounted on eight railroad flatcars the traveler erected a 72-ft. bay containing 350 tons of arch truss and bracing steel in 3½ days and was moved ahead to the next position in less than 2 min. The airship dock is the main unit of the naval air station now under construction on the Pacific Coast about 35 miles south of San Francisco, and will be the base for the Macon (sister ship of the Akron) now being built at Akron. In addition to the hangar, the station will include administrative buildings, shops and barracks for a force of 500 men.

The general design of the Sunnyvale dock is quite similar to that of the Akron dock. Design features and structural details of the latter were described in *Engineering News-Record,* July 24, 1930, p. 135, and the method of erection, utilization of locomotive cranes with special booms, steel falsework and counterweighted cables had been previously described in detail in the issue of Dec. 5, 1929, p. 874.

The dock at Sunnyvale is 1,117 ft. long, 308 ft. wide and 194 ft. high. The frame consists of a series of equal-depth arch trusses on 72-ft. centers and the necessary bracing and roof members. Weight of steel in the frame is about 8,500 tons. A major structural difference in the Sunnyvale design from that used at Akron is the use of three-hinged arches resting on rigid A-frames 55 ft. high. Another difference in design is the introduction of two transverse expansion joints in the frame dividing the structure into three units to reduce end thrust on the door framing and opening mechanisms. Further, the cross-section of the new dock shows less flare on the sides because the Akron hangar served the additional purpose of a factory, and more floor space along the sides was required. Shop and storage space at Sunnyvale is provided on the ground and mezzanine floors.

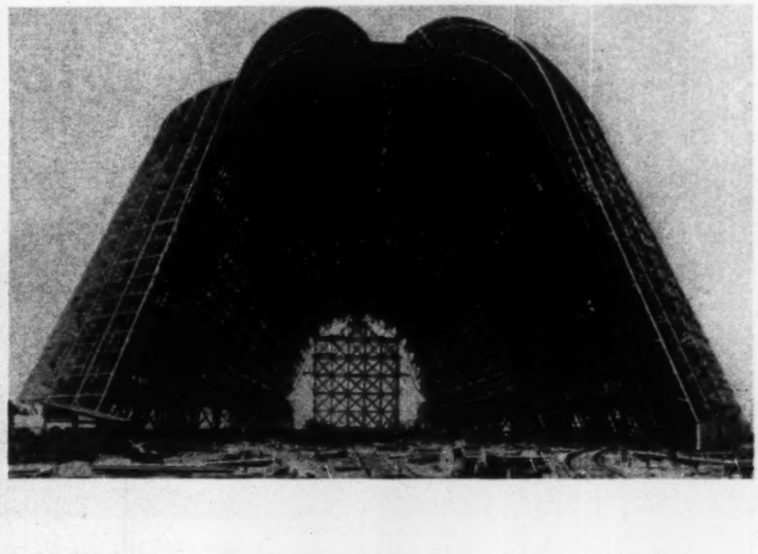
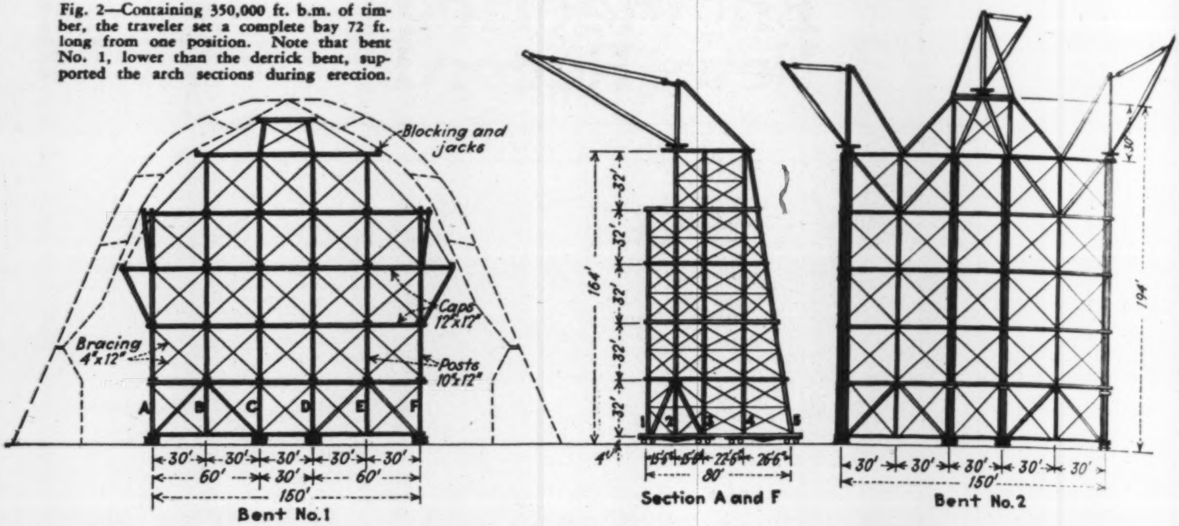


Fig. 1—Backing away from the completed frame as erection proceeded, the traveler is at work on the last bay. Three railroad tracks were extended through the hangar to permit a railroad crane to feed steel sections to the traveler derricks.

The space under the A-frames along the east side also provides for storage for airplanes. However, from the standpoint of steel erection the buildings presented many similar problems, and the methods used on the Sunnyvale dock are described in this article.

Use of a timber traveler, as proposed by the contractor who was low bidder for steel erection, received considerable study from those in charge, since it represented a distinct departure from

Fig. 2—Containing 350,000 ft. b.m. of timber, the traveler set a complete bay 72 ft. long from one position. Note that bent No. 1, lower than the derrick bent, supported the arch sections during erection.



methods previously used. The contractor had had extensive experience in using high timber falsework, however, and after the traveler had been checked for structural requirements the method was accepted.

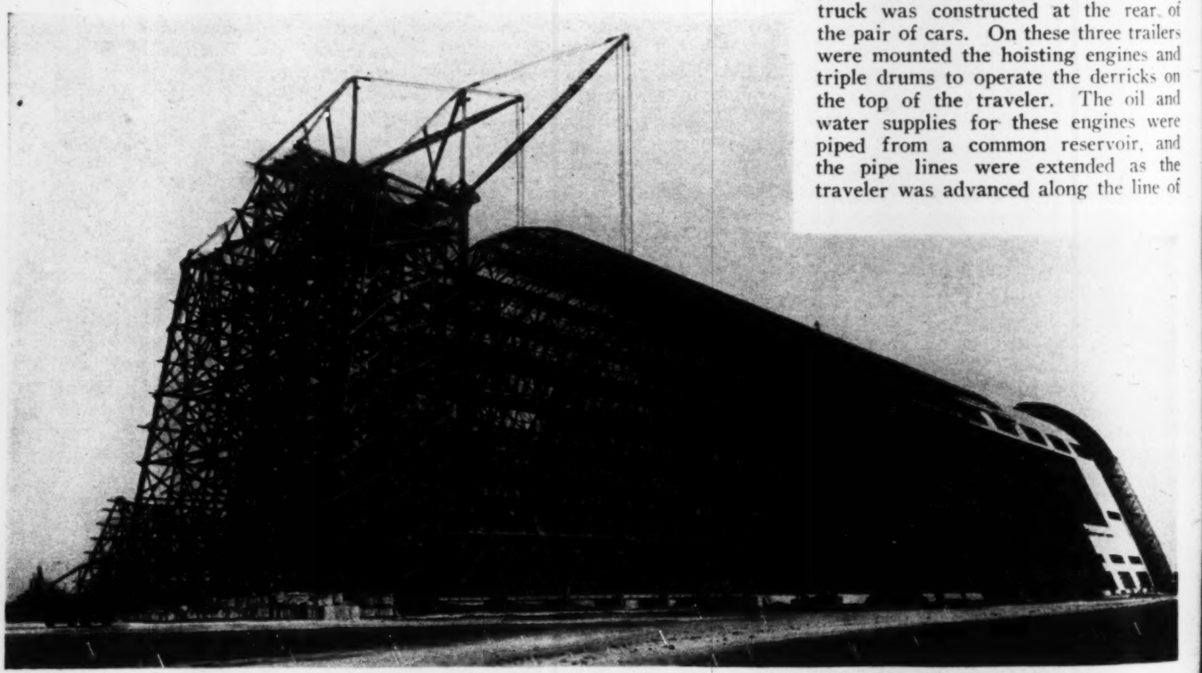
Traveler Design—The traveler was of simple design, consisting of a series of timber bents with conventional framing of 10x12-in. posts, 12x12-in. caps and 4x12-in. crossbracing, using pieces of standard dimensions. Requirements for the falsework were sufficient height, width and stability to permit the three derricks to place all the steel in a 72-ft. bay, with additional provisions for mobility.

The height from the ground to the base of the center derrick was 194 ft., and the two side derricks were on the next level, 30 ft. below. The width of the traveler frame was 150 ft., and the depth along the line of the building was 80 ft. Framing panels for the bents were 32 ft. high (except the last 30-ft. lift) and 30 ft. wide. The distance between bents varied, and the rear bent was on a batter of about 1 in 6. The front bent, ahead of the one supporting the derricks, had special extension caps and brace posts to provide support for the arch-truss sections on blocking during erection, prior to placing the top pin. Framing of the traveler and its relation to the arch trusses is shown in Fig. 2.

The supporting members directly under the derricks consisted of three 12x12-in. timbers increased to about 12x14-in. size near the lower part of the frame. Because the framing layout would place these concentrated loads at the centers of the supporting flatcars, an A-frame was introduced at the lower end to put the load directly on the trucks of the forward cars. The total weight of the traveler, amounting to about 500 tons, was sufficient to eliminate the need for counterweights, although the ends of the derrick legs were made fast to cables, which were weighted with about 18 tons of gravel on the rear cars.

The traveler rested on four pairs of 50-ton railroad flatcars spaced as shown in Fig. 2. On the two outside tracks and on one of the center ones a trailer platform (Fig. 5) supported on a single truck was constructed at the rear of the pair of cars. On these three trailers were mounted the hoisting engines and triple drums to operate the derricks on the top of the traveler. The oil and water supplies for these engines were piped from a common reservoir, and the pipe lines were extended as the traveler was advanced along the line of

Fig. 3—Sunnyvale airdock erection close to completion. The giant timber traveler 194 ft. high is setting complicated steel framing at the rate of 100 tons per day. Note that the reach of the derricks permitted erection of an entire 72-ft. bay.



the structure. Each engine operated a 35-ton derrick with latticed steel boom and timber legs. The side-derrick booms were 100 ft., and the center-derrick boom 85 ft. long.

The traveler was assembled in eighteen days ready to erect the first arch and doors. In this position the entire north end of the hangar was erected, including both sections of the door; thereafter the traveler was moved forward to handle each successive bay with increasing rapidity. Erection procedure was gradually improved and speeded until during the latter part of the work a complete bay consisting of arch truss, bracing, roof members and catwalks, totaling about 350 tons of steel, was erected in 3½ days. On the last move the traveler was in position to erect the doors at the south end of the building.

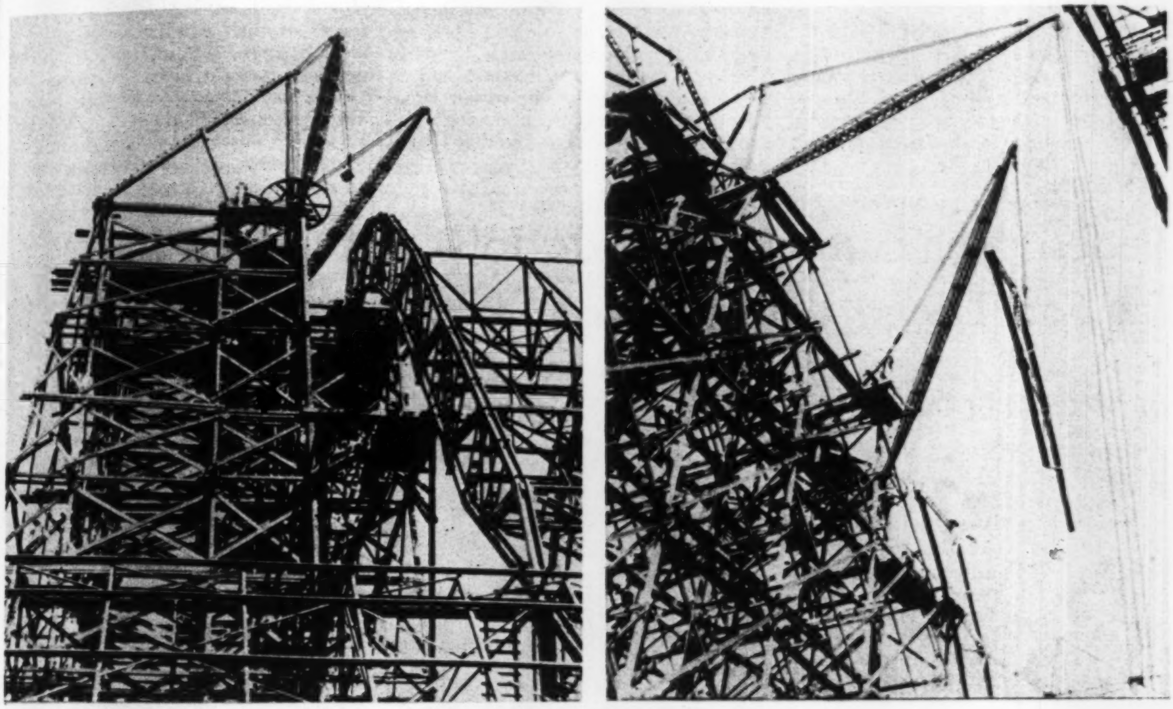


Fig. 4—Views of the traveler in operation. Left, arch erection with sections resting on the first bent of the traveler; right, a 15-ton arch section going into position.

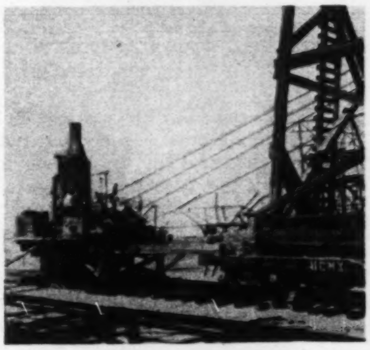
Steel Fabrication—A yard for fabricating sections of bracing was established on the ground outside the building. This yard was served by a railroad track and several spurs, covering the area occupied in fabricating operations. Equipment included a 30-ton railroad crane for handling steel and one 45-ton railroad crane to move the fabricated sections from the yard into the structure and place them directly under the derricks on the traveler for further handling. Riveting crews with oil-fired furnaces working in this yard made up the bracing members into flat panels 72 ft. long. The original plan was to fabricate the sections of bracing complete in this yard, but rate of erection was so rapid that it became necessary to bring in the flat panels and complete fabrication on the ground under the traveler derricks.

A-Frame Erection—The design of the building includes rigid A-frames resting on 968 cast-in-place concrete piles. These frames are 55 ft. high and provide for a pin connection with the lower end of the arch trusses. The frames and the connecting bracing were erected ahead of the traveler by a locomotive crane assisted by a crawler crane. This work did not develop any particular feature and was carried forward easily.

Arch and Framing Erection—For the twelve similar bays that form the main section of the structure the erection procedure was gradually improved and standardized to provide the most efficient use of the traveler, its equipment and crew. Sections of the heavier arch steel and the flat fabricated sections of bracing were brought in by locomotive crane and flatcar and deposited on the ground under the derricks of the traveler. In this position one of the derricks was used to fabricate the bracing sections into fifteen triangular bracing trusses 72 ft. long, weighing about 10 tons each. While these sections of bracing were being fabricated the other derricks were placing the sections of the arch truss that had been fabricated while the traveler was in the previous position. The arch truss was fabricated and erected in six pieces weighing between 15 and 20 tons each (Fig. 4, right).

As each of the six arch sections was set in position it was brought to bear on blocking and jacks resting on the first bent of the traveler. The jacks provided for adjustment during erection and particularly for the placing of the top center pin. Immediately after the arch truss had been pinned, the jacks were removed, and the truss was in final position as a three-hinged arch.

Fig. 5—Mounted on trailers behind the supporting flatcars, the three hoisting engines and drums operated the derricks on the traveler.



In addition to the fifteen sections of main bracing, many smaller sections consisting of purlins, walkways, crane rails and other miscellaneous items had to be raised and set in position. The work was so organized that the derricks on the traveler were in use practically all the time. Since there was no falsework required for any of the arches, there was no delay prior to the beginning of erection in each individual bay.

Moving—One of the most remarkable

features of the erection method was the small amount of time required between the completion of work on one bay and the start on the next. With completion of work on one bay, the booms of the derricks were raised, and lines were run through sheaves on the front end of the flatcars to anchors in the rear. The side engines used a two-part line, and the center engine, pulling the two pairs of cars, used a four-part line. The clamps that held the cars in position on the rails were moved back 72 ft. to the next position. The line from the center derrick was provided with a bridal so that the pull was equalized on the two center tracks. With these simple preparations made, a whistle was blown, and the three hoisting engines were started simultaneously. The traveler started smoothly and moved without weaving. In less than 2 min. the traveler had been moved back to the new position, the rail clamps were then set, and the equipment was ready for beginning the next bay. The crew required to man the traveler, including the fabricating done on the ground, consisted of 32 men.

Construction operations at the Sunnyvale base are in charge of Lieut. Comdr. E. L. Marshall (CEC), U. S. Navy. J. E. Parker is chief inspector. Contract for the steel frame is held by the Wallace Bridge and Structural Steel Co., Seattle, and E. L. Carpenter is resident representative. The firm of J. H. Pomeroy and Co., Seattle and Portland, is doing the erecting. J. H. Pomeroy developed the erection method and is personally supervising the work. V. G. Hindmarsh is construction engineer, and T. R. McDonald is erection superintendent.

◆

Pedestrian Tunnels Provide Jobs for San Diego Unemployed

By Theodore E. Kenny
Assistant Engineer, Bureau of Engineering, San Diego, Calif

PEDESTRIAN tunnels for the safety of school children constituted part of the construction program for San Diego unemployment relief resulting from the $300,000 bond issue voted for that purpose by the city late in 1931. Unemployed men, registered with the civil service commission, were given work by five-day periods at $4 per day, and a rotation schedule provided that the original force be given at least one other work period during the course of the job. The four tunnels were constructed at a cost of $28,775 and provided work for 400 men.

Tunnel locations

Three of the tunnels are located near junior grade schools where the safety of school children was a serious problem, and the fourth was a longer tunnel under the intersection of three of the city's main boulevards for general pedestrian safety. This latter tunnel is 270 ft. long and L-shaped, with stairway entrances at three street corners and two additional entrances in the streets to permit street-car passengers to reach the curb without passing through traffic.

Fig. 1—Typical cross-section of pedestrian tunnel in San Diego, Calif.

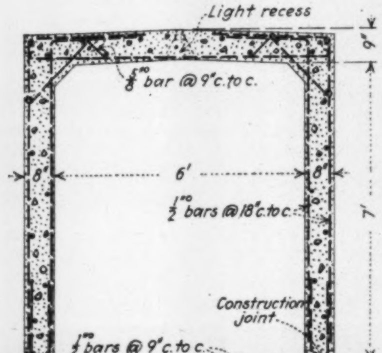

Light recess
9"
$\frac{5}{8}$" bar @ 9" c. to c.
8"
6'
8"
$\frac{1}{2}$" bars @ 18" c. to c.
7'
Construction joint
$\frac{1}{2}$" bars @ 9" c. to c.
8"

Fig. 2—Typical entrance to pedestrian tunnels, which provided temporary employment for 400 of San Diego unemployed.

Structural details

The same cross-section design was used for all tunnels, providing a 6-ft. width and 7-ft. height. The barrel is of reinforced concrete, and its general features are shown in Fig. 1. Construction of the tunnels was completed without interruption of street traffic. Excavation required the use of compressed air because of hard ground, and this added materially to the construction cost. Unit forms in standard lengths were used interchangeably on the various tunnels to reduce the cost of form work, and expansion joints were provided at 30-ft. intervals. Recesses are located in the roof for electric lights, and inlets are built into the floor at drainage points. There are ornamental iron fences at each entrance and an ornamental lantern type of light. A typical entrance stairway is shown in Fig. 2.

The three tunnels at the schools averaged about 72 ft. in length, exclusive of stairways. They cost about $5,000 apiece and gave employment to an average of 85 men each. The 270-ft. tunnel cost $13,500 and provided work for 145 men. The same foreman was employed on each tunnel during the entire construction. The tunnels were built concurrently and occupied a four-month construction period.

Administration

The plans and design were made in the office of H. W. Jorgensen, city engineer, by Wendell Butts under the direction of B. D. Phelps, assistant engineer.

◆

Azimuth Mark Set for Use in Local Land Surveys

Establishment of an azimuth mark at a distance of 300 to 400 yd. from a triangulation station has been the practice of engineers of the U. S. Coast and Geodetic Survey for several years past, according to the June *Bulletin* of the Association of Field Engineers, U. S. Coast and Geodetic Survey. These marks are so set that they can be seen from the ground at the station in order to enable local engineers and surveyors to start their traverses from the triangulation stations. Few such engineers have equipment or experience to enable them to erect towers over the triangulation stations in order to start a line of triangulation. Recently the parties of the survey have been instructed to indicate on their descriptions those objects that can be seen from the ground. Objects so indicated generally are church spires, cupolas, water towers, etc. These objects in first-order triangulation are cut in by the observer, and, in general, the observations depend on two positions with a 9-in. theodolite. Since the total range of sixteen positions on an object is seldom greater than 8 sec., it is reasonably certain, according to the *Bulletin*, that the direction to an intersection station is seldom in error as much as 4 sec., which is sufficiently accurate for general survey and engineering work.

Wood Floor Design for Masonry Wall Buildings

Double-diagonal sheathing best for shear resistance—Tests show that wall anchors need not be large but should be closely spaced

By **Norman B. Green**
Structural Engineer, San Francisco, Calif.

THE LOFT BUILDING with exterior masonry bearing walls and an interior wood frame of beams and columns represents an economical and useful type of construction for buildings up to four or five stories in height, particularly in localities where brick is cheap. It has, however, been seriously handicapped because of the very poor showing such buildings have made in the past when subjected to earthquake shocks or to unusual wind pressure. This article discusses the lateral resistance of such loft structures and presents some new data, with the hope that it will place their engineering design upon a better basis.

This type of building is dependent for its lateral stability upon end walls or interior cross-walls; the wood-floor system serves to tie the structure together and to distribute the lateral load to these bracing elements. The main features of a proper earthquake or wind design comprise, therefore, a floor structure that will resist the bending and shear forces involved, a proper anchorage of the walls to the floor, and some means for taking the end reactions from the floor into the bracing walls. Data on the strength of the bracing walls are available from many sources. The main requirements seem to be a proper bonding of the wall, a mortar rich in cement so as to give a high tensile strength to the masonry, and a minimum of openings, with wide piers and spandrels.

Resistance of wood floors

In the usual structure the bending strength of the floor is a limiting factor. In such buildings the length is several times the width, and the joists run transversely, in the direction of the applied load, while the finished flooring runs lengthwise of the floor area.

A quite common but faulty type of construction involves the use of the finished flooring only, which is laid directly on the joists. A floor of this type can resist direct stress but no shear, since little or no resistance is offered to the sliding of one board past its neighbor. Even if the boards are tongue-and-grooved, lateral shrinkage will soon destroy what frictional resistance may have existed originally. The problem is quite similar to that of the design of the side planking of a wood ship, which must resist the reversed bending and shear stresses set up by hogging and sagging in a seaway. In this service it was found that the horizontal planking alone, even when well calked, offered an insufficient resistance, and the solution was to use iron riders connected to the frames at an angle of 45 deg. in two directions and acting in tension to resist shear forces. In a wood floor, rough sheathing laid in a diagonal direction serves the purpose of the metal riders and enables the structure to resist shear as well as moment. While it is the usual practice to lay the diagonal sheathing in one direction only, this construction will not resist a reversed shearing stress, since a tension is developed at right angles to the boards.

Bending Resistance—The longitudinal tensile strength of a floor is a measure of its resistance to the direct stress produced by transverse bending. This is limited by the number of nails that are effective in resisting rupture of the top or finished floor across any section, and it can be represented very closely by an empirical formula, so long as the boards are laid in a regular manner. If N equals the number of nails per foot width of floor which resist tensile failure, it is found that $N = L\ (2.82 - .097S)$ where L = the length of the boards in feet and S is the joist spacing, either 12 or 16 in. It is assumed here that the boards are 4 in. wide and that there are two nails connecting any board to each joist.

It will be noted that N varies directly as the length of the boards, but, contrary to what might be expected, it is independent of the shift of the butts of adjacent boards. As pointed out, however, the boards must be laid in a regular manner with a uniform shift, otherwise the value of N will vary irregularly and will not be susceptible of calculation. A shift of either three or four joists gives a good lateral strength distribution for boards up to 24 ft. long, and a lesser shift should not be used.

If now R equals the lateral resistance of one nail and d is the width of floor resisting bending, while M is the resisting moment in lb.-ft.,

$$M = \frac{R\,d^2\,L}{6}(2.82 - 0.097S) \qquad \textbf{(1)}$$

It is assumed in this derivation that the neutral axis lies at the center of the width of the floor and that the stresses of tension and compression follow the usual linear relation.

Shear Resistance—Transverse shearing forces in a plank floor must be resisted by diagonal boards laid in two directions and in two planes. Here again the problem reduces to that of determining the number of nails that are effective in resisting rupture of the diagonal flooring along any transverse section of the floor. For boards 6 in. wide laid at an angle of 45 deg., this is expressed quite accurately by the empirical formula

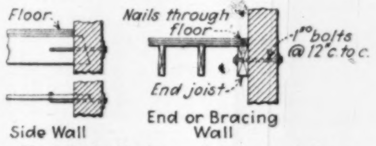
$$N = (0.82d - 0.03dS - 3)\,L + 2.1\,d + 7$$

In this case also the value of N is independent of the shift of the butts, although the same limitations apply as for the finished flooring.

If this quantity N is multiplied by the lateral resistance R of one nail and by the secant of 45 deg., the total shear resistance will be secured. It may be expressed by the formula

$$V = 1.41\quad R\,[(0.82d - 0.03dS - 3)\,L + 2.1d + 7] \qquad (2)$$

Values of M and V, computed for varying width of floor, length of boards and joist spacing, from formulas (1) and (2), are given in Table I. These values are based on the use of 8-d nails, and R has been taken at 164 lb., which is assumed to be the elastic limit strength or yield point of one nail. The values of M and V for any other size of nails or nail load, may be obtained by multiplying the tabular values by the ratio of this load to 164.



Typical details for anchoring wood floors to masonry walls to resist earthquake or pulsating wind forces.

Anchorage of wall to floor

The side walls of the building derive their lateral support from the floor, which transmits the resulting load to the end walls or to interior cross-walls. So far as wind load is concerned, the wall simply presses against the embedded ends of the joists; but under earthquake shock the heavy mass of the wall must be accelerated in either direction, and this necessitates some form of floor anchor that will resist tension. This usually takes the form of a metal rod that hooks into the side of the joist near its end and thence passes through the wall to a plate on the outside, as indicated in the accompanying sketch.

The strength of this type of anchor is limited by the resistance of the hooked connection to the joist. In Table II the third column gives the average ultimate strengths developed by a series of mild steel joist anchors, tested in 2-in.-thick

TABLE I — SHEAR AND BENDING RESISTANCE OF WOOD FLOORS

S (Inches)	L (Feet)			M (Kip Ft.) V (Kip)	Width of Floor d in Feet											
	Nominal	Longit. Bds.	Diag. Bds.		20	25	30	35	40	45	50	60	70	80	90	100
12	12	12		M	217	338	488	665	867	1100	1355	1950	2660	3470	4400	5420
			11.2	V	27.6	35.8	44.4	52.8	61.1	69.6	78	94.6	111.4	127.4	145.4	161.6
	16	16		M	290	453	653	890	1160	1470	1813	2610	3550	4640	5880	7250
			15.4	V	33.6	44.2	54.8	65.6	76.0	86.6	97.4	118.6	140	161.4	183	204.4
	20	20		M	362	565	814	1110	1446	1830	2260	3255	4430	5780	7320	9040
			19.5	V	39.4	52.4	65.2	78.0	90.6	103.6	116.4	142.4	168	193.8	219.4	245.2
	24	24		M	435	680	978	1330	1740	2200	2720	3910	5320	6950	8800	10870
			22.4	V	43.6	58.0	72.4	86.8	101.2	115.6	130.0	158.8	187.6	216.8	246	275.2
16	12	12		M	165	258	372	507	661	838	1035	1490	2027	2647	3350	4140
			11.2	V	21.2	28	35	41.8	48.8	55.6	62.4	76.2	89.8	107.4	125	142.6
	16	16		M	222	346	499	678	886	1120	1385	1995	2716	3550	4490	5540
			15	V	24.6	32.8	41.2	50	58	66.4	74.6	91.2	108	130	152	174
	20	20		M	275	430	620	845	1110	1395	1725	2480	3380	4410	5580	6900
			18.7	V	27.8	37.8	47.6	57.2	67	76.6	86.6	106.2	126	152	178	204
	24	24		M	330	516	745	1014	1323	1680	2070	2980	4050	5240	6700	8280
			22.5	V	31.0	42.4	53.8	64.6	76.4	87.6	98.8	121.4	144	176	206	238

TABLE II — STRENGTH AND SPACING OF JOIST ANCHORS

Size of Anchor (In.)	Test Results		Working Load (Lb.)	Wall Thickness (In.)	Wall Area per Anchor (Sq.Ft.) Seis. Coeff. = 1/10
	No. of Tests	Av. Ult. Strength (Lb.)			
½	4	3,380	1,690	9 13 17 21	203 141 106 87
⅝	7	4,150	2,075	9 13 17 21	247 173 130 107
¾	6	4,970	2,500	9 13 17 21	300 207 155 128
⅞	6	5,920	2,960	9 13 17 21	357 246 184 151

Oregon pine joists. In these tests made recently by the author in the laboratory of the engineering department of the University of California there was a rapid deformation exhibited from the initial load, while the stress-strain lines, which are rather irregular, show no break that might be described as a yield point. The working load must therefore be referred to the ultimate strength. In view of the fact that the ultimate strengths developed by the same size anchor tested in different specimens of wood vary by as much as 100% among themselves and 47% from the mean, it is not believed that a factor of safety of 2 is too large, and this value has been employed in arriving at the working loads given in the fourth column of the table. These loads represent a deformation of the joint of about one-tenth in., the elongation at maximum load varying between ¼ and ½ in.

An examination of Table II will show that the average ultimate strength of the anchors varies directly as the diameter of the rod, indicating that the controlling element in this respect is the resistance of the wood in end-grain bearing and not the bending resistance of the hook, which varies as the cube of the diameter. It is therefore economical to use anchors of small diameter with a relatively close spacing, since these have a greater strength in proportion to their weight.

While the usual manner of failure was by elongation of the hole, accompanied by opening and slipping of the hook, there were three anchors that failed in tension at the bend of the rod. The possibility of this type of failure, when the anchors are bent cold, as is the usual practice, indicates the importance of ductility in the metal and the advantage in this respect of using rivet steel rather than structural steel. It is furthermore unlikely that there would be any loss of strength due to the employment of a steel of low tensile properties, in view of the apparently small influence of the bending resistance and stiffness of the hook.

The last column of Table II gives the maximum spacing of the anchors in terms of square feet of wall, assuming an earthquake acceleration of one-tenth gravity. The corresponding spacing along the wall depends upon the story height, since this spacing times the story height should equal the tabulated wall areas. Where there is a change in wall thickness at the floor, the average wall area for the thickness above and below the floor should be employed. In case there are window openings, these should be deducted in computing the area of wall supported by a single anchor.

There are two additional factors besides the strength of the anchors which should be considered in determining their spacing. The first of these is the flexural strength of the wall between anchors, and the second is the number of nails connecting the anchor joist to the floor sheathing, which must be sufficient to resist the pull of the anchor. Only under very exceptional conditions of excessive anchor spacing or very short joist spans adjacent to the wall, will either of these factors prove to be a controlling element.

Floor anchorage at bracing walls

It is entirely useless to anchor the side walls to the floor and provide bending and shear resistance in the floor structure unless some means is provided for taking the end reaction from the floor into bracing walls. This is most conveniently accomplished through the medium of an end joist or timber, which is bolted to the bracing wall and nailed to the floor sheathing.

Consider, for example, a floor 50x100 ft. in plan, consisting of joists 16 in. on centers and floor boards 16 ft. long. The maximum resisting moment that this floor can develop is, from Table II, 1,385,000 lb.-ft., which with a uniformly distributed transverse load represents an end reaction of 55,400 lb., or 1,110 lb. per ft. This would require seven nails at 164 lb. working load and one 1-in. diameter bolt through the wall. The nails can be accommodated conveniently in an end joist 4 in. wide, such as is shown on the accompanying sketch.

◆

Car Ferry and Landing Projected for Yangtse-Kiang, China

To provide through rail transport between Pekin and Shanghai, the Chinese government has ordered the construction of a car-ferry steamer and landings for the crossing of the Yangtse-Kiang between Pukow and Nanking, on the north and south banks, respectively. Each landing will include four 154-ft. truss spans, with trusses spaced 20 ft. c. to c., except that the outer or river span will have trusses 44 ft. c. to c. to permit of three diverging tracks to connect with the tracks on the boat. A contract for the landing spans has been awarded to Dorman, Long & Co., Middlesborough, England, while the operating machinery will be built by Thomas Broadbent & Sons under a subcontract.

The Supply Dealer's Changing Place in Materials Distribution

Although modern methods tend to eliminate the supply dealer from many construction operations, he is still an indispensable part of the system

By O. Fred Rost

Marketing Editor, The Business Week
New York

In This further article of the series on distribution of construction materials, begun a year ago, the author indicates the influences that have reduced the dependence of construction operations on the dealer. He finds that modernization of the dealer's business practice and attitude is essential to his continuing success, but also that the engineer and the contractor have good reason to study carefully their relations to the dealer, in the interests of lowest job cost. Earlier articles in the series dealt with the distribution problem generally (Sept. 10, 1931, p. 400), with brick (Sept. 17 and Oct. 1, 1931, pp. 441 and 536), with distribution of aggregates (Jan. 14, 1932, p. 59), and with demoralization and reorganization of the cement industry (March 17 and April 7, 1932, pp. 404 and 513).

DISTRIBUTION of construction materials and supplies proceeds through numerous channels that are functionally identical but represent a varying degree of directness in the routing between producer and user. The shortest route of distribution is from the producer directly to the user or consumer; some lumber, much steel, cement, cut stone and most of the sand and gravel used in construction jobs are so sold. In proportion as other agencies, such as brokers, speculators, wholesalers, dealers and contractors, become factors in the distribution of any commodity, the route traveled by the material (or at least its theoretical course of travel), as determined by changing ownership, becomes more complicated and correspondingly more costly, because each factor involved adds some expense and generally also a profit.

It is rarely possible for even the largest contractor or the most efficient engineering organization to complete a construction job without procuring a greater or lesser portion of the materials or supplies needed through a secondary agency or dealer. Frequently the degree of promptness and efficiency with which a dealer is able to meet the current requirements of contractors and engineers has direct and important bearing on the final net profit on a given operation.

Dealers differ in the completeness and scope of their activities, according to the size of the community and the degree to which each has become the key figure for materials distribution in the area. In the average town or city every local dealer generally handles every conceivable type of material that is used in various construction jobs, and except on large or government jobs little if any construction material enters the territory that is not obtained from or through him. In the larger cities there are few general building-supply dealers who handle a complete line; but instead, dealers specialize in lumber, sand, stone, mason materials, brick, roofing or some other particular class of construction materials.

As it would go beyond the purpose of this series of articles to deal specifically and separately with each group of materials dealers, the present article will consider those dealers who are factors in the distribution of the most important classes of materials. It will outline the practices that prevail among them and the commercial or external influences to which they have been subjected in recent years. Such dealers stock a more or less complete line of all the various materials that are ordinarily used by the construction industries, and they account for a very representative portion of the country's total volume of business.

1929 business nearly four billions

According to the U. S. census of distribution, there were more than 79,000 lumber and materials-supply dealers in business at the beginning of 1930. They reported a gross sales volume of $3,637,000,000 for the year 1929, which represented 7.27 per cent of the country's total volume of retail business. If the total volume of construction business in the United States done during the same year is estimated to amount to something more than ten billions, the value of materials handled by lumber and materials-supply dealers represented between 30 and 40 per cent of the total spent in construction work. These figures serve to make it clear that, despite the changes to which the construction industry has been subjected in recent years, the dealer still constitutes an important part of the distributing mechanism through which materials travel from producer to user.

Originally the materials-supply dealer was evolved out of the lumber dealer. The primary development of a community always creates the need for shelter. This in turn gives someone an opportunity to buy large quantities of lumber and other materials used in building or construction and sell them to the local contractor or user as needed. The dealers who thus came into being generally prospered. They added other allied commodities as the occasion demanded and as construction jobs became more complicated or demanded different or new materials. Today the up-to-date dealer in materials and supplies carries in stock thousands of different items which he accumulates from producers or manufacturers located in many different cities and keeps available so as to be able to supply the needs of his trade promptly. Frequently he is the means of introducing new materials and methods, which directly or indirectly contribute to the prosperity of the contractor and the comfort of the public.

In many communities, moreover, the materials dealer has had an important part in the planning and execution of major public improvements and large housing projects. Frequently extensive construction jobs have been undertaken because a dealer had the initiative to promote them and the ability to finance them wholly or partially during the construction period. Often a dealer has been a vital factor in arranging for the permanent financing of extensive public works and improvements.

Decreasing profits

Until the post-war building boom subsided the average materials-supply dealer did not find it difficult to obtain a satisfactory volume of business and earn a profit. Unrestricted immigration and a continually growing population supported a steady demand for homes, streets, roads, schools, public buildings, etc., so that the construction industry thrived, and with it the materials dealer. Unfortunately the latter came to believe that the market for materials was capable of indefinite expansion. But in recent years many factors have combined to make it more difficult for the dealer in materials to exist. The most important of these are: drastic reduction in most types of construction activities for some years past; new methods and substitute materials; direct sales by producers to the contractor or consumer; and mail-order competition in the building field.

There is perhaps no other industry in which so many new methods or substitute materials have made their appearance as in the construction field. In heavy construction steel and concrete have taken the place of timber. Roofing, partition and wall materials increased in number. Structural aluminum and stainless steel are among the newest additions. Many of the new materials were introduced through national advertising, on the theory that the public as such must be made acquainted with them in order that consent to their use in contemplated public works or construction jobs may be more easily obtained. Materials dealers resented such invasion of their field by any direct sales attack to promote substitutes or new materials; some refused to stock them, while a few even refused to clear orders for such materials through their organization.

This reluctance or lack of foresight on the part of materials dealers to recognize the influences and changes to which their market was being subjected has substantially contributed to the growth of the third factor. For, when manufacturers found it impossible to obtain distribution for their goods through existing dealers or other ordinarily recognized channels, they had no other course than to sell their goods direct to the contractor or consumer.

Some manufacturers continued to enforce a scale of prices that provided for protection of recognized materials dealers in territories where dealers were functioning. Others decided to give the contractor the same prices they would extend to established dealers, and some have discontinued protecting any dealer, agent or other intermediary if a consumer wanted to buy for a specific job. Still other manufacturers, who found it impossible to obtain distribution of their products through existing channels, established independent agencies and trained sales forces, each man concentrating his selling in a comparatively limited territory, generally with excellent results.

Special factors of change

The practice of direct selling by the producer to the contractor or consumer was stimulated, furthermore, through the growth in the size of various construction jobs. Many general contractors found it profitable to establish connections direct with new and old manufacturers who were not securing satisfactory or sufficient distribution in a particular territory through established dealers. Sometimes such contractors are in a position to place a single order, perhaps covering only the requirements of a single job, that in dollar value far exceeds the total of a large number of small orders placed by the average dealer. By this procedure these contractors naturally avoid the necessity of having to pay the materials dealers a differential or commission on materials that are shipped by carload or truck direct to the user or to the point of use. Because of the fact that in such transactions the dealer performs no real function other than placing the order with the manufacturer and clearing the transaction through his books, this practice has been defended as being economical and justified.

The growth of motor transportation served to accelerate the trend toward the elimination of the dealer from certain types of business. Motor trucks are today obtainable for hire or on contract in practically all territories. They provide economical and flexible means of obtaining at reasonable cost transportation of needed construction materials from distant mills, mines and quarries directly to the place of use. The greater cost of actual transportation by truck per mile, as compared with rail shipment, is more than made up by the saving of several handlings. Trucks have eliminated the need for intermediaries between producer and contractor to look after ordering and shipping by freight, local handling and the various other functions previously necessary to insure a regular flow of materials to the job.

Direct purchasing

Sand, stone and cement are some of the materials which, during recent years, have been sold in much greater volume direct from the producer to the consumer. While this change came about through entirely natural causes and through circumstances over which the manufacturer had little or no control, it has nevertheless been the subject of much controversy between producers, manufacturers and materials dealers.

With the increase in the building of concrete roads and the general increase in the use of concrete for construction jobs, federal, state and municipal authorities decided that they should no longer pay a commission or differential to dealers on materials not actually handled by those dealers. In cement, for example, the fact that cement was being sold under standardized specifications eliminated practically all argument of quality and made it possible for these governmental bodies to advertise for bids, knowing that no matter who might supply the needed cement they would secure a satisfactory material. The practice of government bodies in purchasing these materials direct from the producer has increased very rapidly; and this process, although it has taken from materials dealers a definite percentage of business that they previously enjoyed and has deprived them of the opportunity to collect unearned commissions or differentials on a large volume of material, is strictly in line with the steadily growing tendency in every industry to eliminate unnecessary burdens on the cost of distribution.

The fact that these changes in policy or revised practices of distribution were removing a steadily increasing proportion of the available volume of business from their control did not become apparent to many materials dealers until after 1925, when the post-war boom had run its course and available sales volume began to shrink.

The situation of the dealer specializing in building supplies became further complicated when two large mail-order houses decided to promote the sale of building materials and completed homes. One of these established a separate department for this activity and inaugurated an aggressive selling campaign. It laid out lumber yards at the seaboard, equipped them with modern material-handling machinery, and offered not merely building-supply lumber but construction timber and all kinds of materials at prices that were often lower than those charged by the long-established dealers. It also offered to erect standardized homes against a small down-payment on any site owned by the purchaser. While the sales of materials by the mail-order houses constitute a small portion of the total, aggressive selling methods may be expected to bring them an increasing share of business in this field previously unexplored by them.

A survey of changes

The cumulative effect of these several factors—new methods, new materials, new policies, new competition—on the business of representative materials dealers is effectively demonstrated by the findings of a special survey recently made by the McGraw-Hill Publishing Co. Analysis of the results showed that practically all materials dealers had experienced definite and in some cases drastic declines in that part of their business made up of items that the industry had always considered as staple.

One important dealer in a well-known city of the Southeast reported that his sales of portland cement, which in 1920 formed more than 33 per cent of his total sales volume, dropped to less than 20 per cent by 1930. His sales of plaster dropped from 25 to 15 per cent, face brick from 20 to 10 per cent, and common brick from 7 to 3 per cent of his total sales. Yet in the same period his total sales volume showed a substantial increase.

A dealer in an Eastern city, with whom sales of cement represented more than 50 per cent of his total in 1920, reported that by 1930 they had shrunk to 35 per cent, while the sales of other staples, such as lumber, brick, lime, etc., had dropped 5 per cent below their 1920 share.

An Indiana materials dealer found that in 1930 his sales of cement were 30 per cent, plaster 4 per cent, face brick 2 per cent, common brick 4 per cent less than the portion of total sales represented by the same materials in 1920.

However, many of the losses in sales volume in what might be termed old-line staples were offset by proportionate increases in substitute or entirely new materials. Some dealers made up their losses of cement sales by sales of ready-mixed concrete, on which incidentally they earn larger profit. Losses in the sale of timber were made up by increased sales of steel. Metal lath was sold instead of wood. Where the sale of plaster and lime declined, plaster board, wall board and other substitutes were sold, often in larger dollar volume.

One New England dealer, for example, with whom sales of lumber represented 75 per cent of his total in 1920, saw that proportion drop more than 15 per cent in ten years, but in the same period his sales of lumber substitutes rose from nothing to the very important position of 26 per cent of his total sales.

Thus it is evident that a serious and important shifting in the type of materials used for specific purposes has been in progress. New materials and processes have deprived older materials of their market. Disregarding some presumably ironclad traditions in the field, many manufacturers have sold materials through other chanels or sold them direct to the contractor, so that an increasing proportion of the money spent for construction work has bypassed the dealer and is now going directly from the contractor or buyer to the producer of the material.

Has the dealer adapted himself?

The industry as a whole has been slow to recognize the significance of the changes that were taking place. Many dealers suffered loss of profit, loss of sales volume and even final failure without reaching at any time an accurate understanding of the underlying factors that were responsible.

Even today there are materials dealers who believe that only through the application of artificial stimulants will they be able to maintain themselves in business. These dealers attempt to dictate to producer and manufacturer the price schedules that he is to enforce, the policies he is to pursue, or the classes of customers to whom he should or should not sell his goods. Dealers of this same type urge price-fixing legislation, abandonment of the Sherman anti-trust act and other radical departures. They argue that the materials dealer is an economic factor and a necessity, and as such deserves protection at any cost.

Other dealers, more progressive, have recognized the economic changes that are taking place around them and adjusted their policies and methods of doing business to the new situation. They have placed their operations on a basis where each activity must justify itself on its merits and must produce a profit for the business. They have capitalized the advertising and sales promotional activities of materials manufacturers. Through properly trained sales personnel they are securing from their territory a satisfactory share of business.

Today an experienced observer is readily able to classify a materials dealer by taking a look at his place of business. The unprogressive dealer is operating his yard as he did twenty years ago, and as a result is doing perhaps no more business than at that time and making substantially less money. The up-to-date materials dealer generally has departmentalized his business. He has separated heavy construction from building supplies; he employs salesmen who are specialists in their field and who actively and successfully promote the welfare of their particular department.

Some of the materials dealers who have special departments for building supplies have definitely abandoned the theory that they should permit the building contractor to remain the only and exclusive contact with the ultimate consumer. They employ trained contact men, experienced in engineering and architectural work, who consult with the contractor and the engineers or architects representing the final consumer, so as to insure satisfaction and incidentally obtain for their employer the order for the materials to be used. Many such dealers maintain merchandising departments and salesrooms where various types of construction materials, building supplies and accessories are on permanent display. Many materials dealers now study their territory and attempt to determine definitely the area that must be cultivated by their sales force in order to develop the desired volume of sales.

A nation-wide study of materials dealers shows that a majority obtained their business within a radius of less than 50 miles from their office. In some of the more sparsely settled sections of the country dealers reported that their operations extended a distance of 100 miles away. The study also developed the very important fact that a majority of these dealers carried during 1930 an inventory of materials that in dollar total represented only 10 per cent of their total dollar volume of sales. This figure compares extremely favorably with the performance of wholesalers or distributors in other lines of industry, who enjoy a much smaller gross margin of profit than is generally accepted by the dealer in construction materials.

The dealer's future position

Obviously, the materials dealer still occupies a very definite place in the system by which the construction industry, the contractor and the engineer obtain needed materials. In connection with the stocking or supplying of certain types of materials the functions performed by the dealer are entirely indispensable.

But the distribution of other materials, chiefly those used for heavy construction, may be expected to proceed in increasing volume without the aid of regular materials dealers, because the quantities involved and the burden of tonnage to be moved demand that these materials should travel by the straightest, shortest and least involved route from the point of their production to the place where they are to be used. It follows that the engineer or contractor will in future use the facilities of a dealer only to such degree as the financial capacity and the physical stock and equipment which that dealer commands enable him to provide an economical service.

The time obviously has passed when a materials dealer can safely demand or peaceably enjoy a margin of profitable protection in price, clientele or territory merely by virtue of precedent, tradition, influence or because of the evident fact that he is now in existence and naturally wants to continue to stay in business. The pressing need for the narrowing of margins between the cost of production and the cost to the ultimate user will make this impossible.

The process which in other fields has ruthlessly and relentlessly eliminated useless and therefore parasitical burdens from the cost of distribution is actively at work in this field. The dealer who finally survives will be prepared to render a definite and indispensable service in connection with the sale and distribution of every type of materials

As to engineer and contractor

Every engineer or contractor is interested in keeping costs down to the minimum. Where the size of the job would make it impracticable to establish a local buying office or purchasing agent, it is important to establish relations with the best financed and best equipped materials dealer. Such connection will prove invaluable and contribute materially to the speedy completion of the work.

When jobs are of a size that makes the establishment of a local buying office debatable, it is well to keep in mind that the higher prices that generally have to be paid to the dealer may well be offset by the time gained in getting materials and the convenience of buying in quantities as needed rather than in quantities specified by the producer or manufacturer as minimum if lowest prices are to be secured. Buying direct from distant suppliers involves several added items of cost that are frequently uncertain or unknown but that build up the final cost, as for instance cost of freight and hauling, clerical labor, postage, checking invoices, accounting, making payments, etc. Most of such factors are eliminated or simplified when the bulk of materials is obtained from one central source.

When the size of a construction job obviously justifies the establishment of a complete buying and accounting office, however, the materials dealer can serve only in supplying pick-up quantities or odd items to meet a specific emergency. It therefore appears evident that the lowest cost on any job of construction can be secured only if the engineer in charge or the contractor is able to determine correctly to what extent he can employ economically the services of a dealer in obtaining the necessary materials.

Parabolic Vertical Curves for Highway Grades

Principles, formulas and charts for clear-vision curves according to three classes of highways

By M. W. Furr

Professor of Civil Engineering, Kansas State College, Manhattan, Kan.

THE SUBJECT of parabolic curves for highway grades, in the writer's estimation, has not been sufficiently emphasized. There are many instances in engineering operations where insufficient knowledge of fundamental principles results in poor layouts. A few charts similar to those shown by Figs. 2, 3 and 4 have been prepared, but the classification given in this article has not been made. Moreover, the previous solutions of the problem and the preparation of charts have been inexplicit. Also, it is believed, no solution has previously been given for the case when L is less than l; as by equation (11) that follows. For these reasons this explanation and review have been prepared.

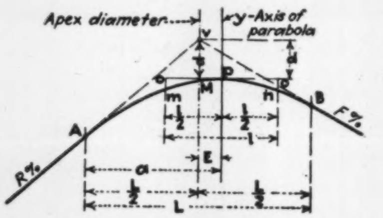


Fig. 1—Diagram showing fundamental relationships for parabolic vertical curves for highway grades.

The common cases for the application of the following principles are where grades of opposite slope meet at (1) summit locations and (2) in valley crossings. The situation of the curve and the fundamental relationships are given with reference to Fig. 1.

$$x^2 = (\pm)\, 4py \qquad (1)$$

$$VM = \frac{KL}{8} \qquad (2)$$

where VM is the apex ordinate, K is the algebraic difference of grades in per cent, and L is the length of the curve in stations.

The plus or minus sign will be dropped from equation (1), since the position of the parabola is understood. The ordinate distances y vary as the square of abscissa distances (L values) and are reckoned from the tangent points to the apex ordinate VM. This calculation is readily made with sufficient accuracy by means of an ordinary slide-rule. The signs of R (plus) and F (minus) must be regarded in the use of the following formulas.

Clear-vision solution

It is sufficient to say that ample clear vision is required at hilltops for the safety of traffic. The length of vision necessarily varies more or less with the importance of the road as a traffic way. The height of the point of vision, ordinate distance h ($om = on$), is usually taken at 5 ft. above the grade; and the length of view is from 350 ft. for class III roads to 800 ft. for class I roads. This hypothesis conforms with the recommendation of the American Association of State Highway Officials (Figs. 2, 3 and 4).

There are two conditions to be analyzed: (1) when the length of vertical curve required is less than the stipulated vision; and (2) when the length of vertical curve required is equal to or greater than the stipulated vision. The second case has been fully presented by the author in *Engineering News-Record*, May 20, 1926, p. 819, and Aug. 12, 1926, p. 268. The primary object of this discussion is to explain the first case, and it is believed that the following exposition is new. The calculation is made by equation (11) for that part of the diagrams, Figs. 2, 3 and 4, shown curved. A brief review of the second case will be given as a premise.

For grades AV and VB, or vice versa:

$$y = RE + R^2p \qquad (3)$$

$$y = FE + F^2p \qquad (4)$$

$$L = 2pK \qquad (5)$$

$$p = L \div 2K = l^2 \div 16h \qquad (6)$$

$$L = \frac{l^2 K}{8h} \qquad (7)$$

$$E = pC \qquad (8)$$

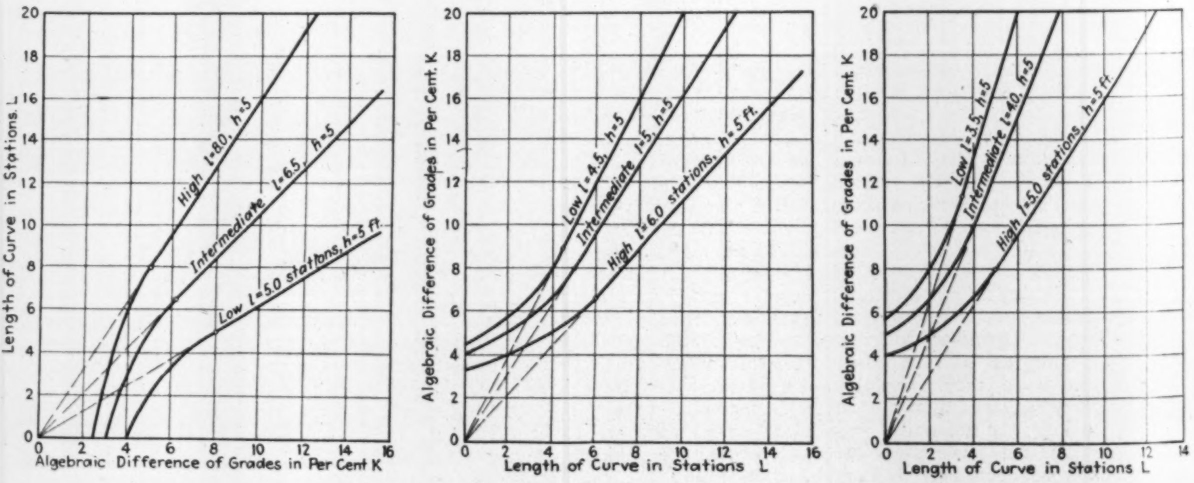
$$d = RFp \qquad (9)$$

$$a = \frac{L}{2} \pm E = \frac{LR}{K} = \frac{l^2 R}{8h} \qquad (10)$$

where R is the rising or plus grade, F is the falling or minus grade, K is the algebraic difference of grades, and C is the algebraic sum of grades, each in per cent. L is the length of the vertical curve in stations and is symmetrically placed about the apex diameter, and l is the stipulated length of vision in stations (Fig. 1).

The length of the parabolic curve necessary to give the stipulated vision when L is less than l (case I) may be calculated by equation (11).

$$L = 2l - \frac{40}{K} \qquad (11)$$



Figs. 2-4—Vertical parabolic clear-vision curve charts for three classes of highways.

For example, when L is less than l, let elevation $V = 165.30$, $R = 3.30$ per cent, $F = 1.70$ per cent, $l = 6.5$, and $h = 5$. By equation (11) $L = 5$. By equation (8) or (10) the high point of the curve will be 330 ft. from point A. By equation (9) the elevation of the high point is 162.50. For check:

$$\left[\frac{5\times5}{8}\right]\left[\frac{1.7}{2.5}\right]^2 = 1.44$$

$$165.30 - [0.8 \times 1.7 + 1.44] = 162.50$$

The points of observation at 325 ft. each way from P will be intervisible, as the relative elevations that may be calculated will show. The low point of any curve in valley location can be found easily from the foregoing equations in a similar manner. Conversely, the length of a regular parabolic curve necessary to pass the curve through a point of known elevation and station number is easily obtainable.

Replacing Plate-Girder Bridges by Inverting the Spans

By T. Kuroda

Chief of the Improvement Section, Bureau of Maintenance and Improvement, Japanese Government Railways, Tokyo

A NEW METHOD of replacing plate-girder spans in a short train interval, devised by the writer, has been used with entire success in a number of recent replacements in Japan. As no falsework is needed, the method is economical. The following gives some details of the method and the results of its first application.

Principle—The new span is placed upside down on roller trucks and is conveyed to the site of the replacement. It is placed on top of the old one on special end shoes, and the two are fastened rigidly together by box-girder end diaphragms. The assembly of spans is then lifted by jacks, and its weight is supported on trunnions fixed in castings bolted to the box-girder diaphragms, journaled in pedestals mounted on the approach. The trunnions are in the center of gravity of the whole mass, and therefore the girders can be turned easily until their positions are reversed. Then the pair of spans is lowered by means of the jacks, so that the new girder rests on the abutments or piers. The old girder is then placed on the roller trucks to be carried away.

Before the new girder is brought to the site it is fitted with rails and ties except over a length of a few feet from each end; screw spikes are used instead of driven spikes. The roller trucks are so constructed that their upper and lower halves are symmetrical. The box-girder diaphragms that connect the ends of the spans are shown in Fig. 2. Trunnions 4½ in. in diameter, which can be readily put in or taken out, are seated in castings bolted to the box girders in the center of gravity of the whole assemblage. The lower flange of the box-girder diaphragm rests on the top flanges of the old span, while the new span rests on shoes set on top of the diaphragm.

Fig. 1—Replacement by inversion, Tachikiri Bridge, at Taketoyo, Japan, done in 90 min.

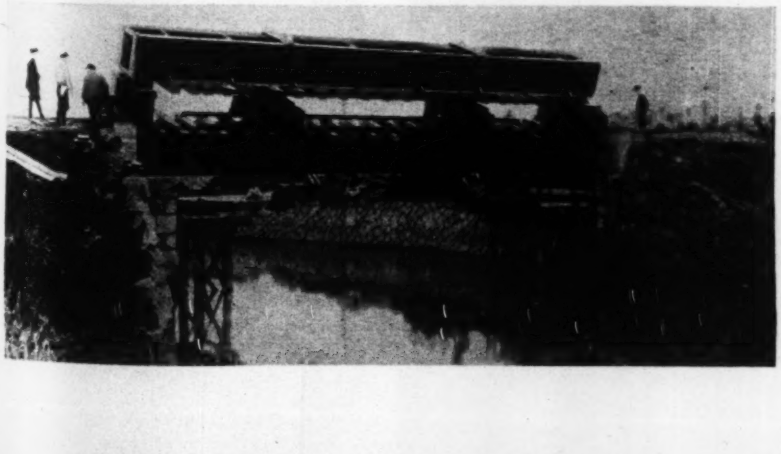
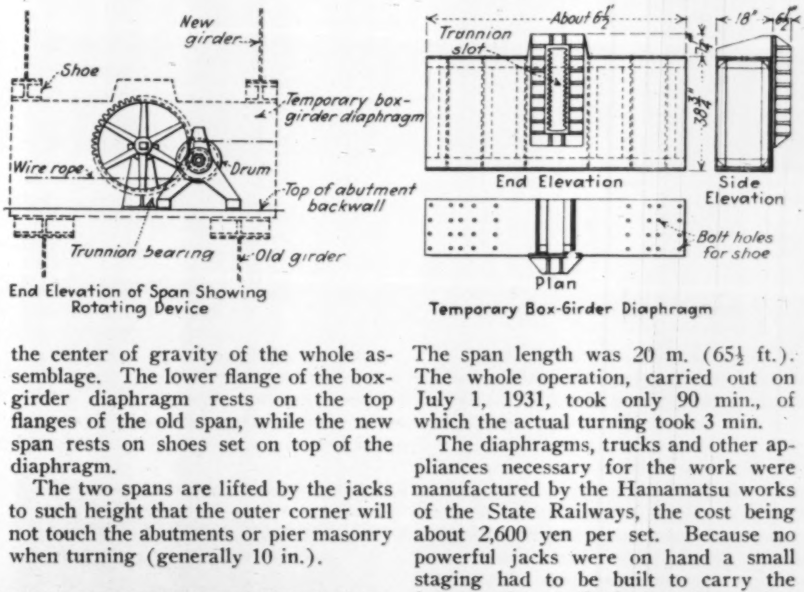


Fig. 2—Trunnions seated in castings bolted to heavy box-girder end diaphragms are located on the center line of the superimposed spans permitting easy turning by gear drive actuated by rope winches.



End Elevation of Span Showing Rotating Device

End Elevation

Side Elevation

Temporary Box-Girder Diaphragm

The two spans are lifted by the jacks to such height that the outer corner will not touch the abutments or pier masonry when turning (generally 10 in.).

A rope that is connected with the drum of the turning device is drawn out slowly and steadily by two winches installed at each end, until the position of the two girders is reversed. Theoretically, the spans are always in equilibrium while being turned, but in practice the center of gravity may not be quite where calculation indicates; hence the powerful turning device and the equipment for steady drawing out of the rope.

After the spans are inverted they are again supported on the jacks, the turning device is removed, and the girders are lowered until the new one is settled upon the abutments or piers. Then the new girder is cut free from the diaphragms, and the old girder is lifted by the jacks and rolled away on the trucks.

First Application—This new method of replacing plate girders was applied for the first time to a bridge over the river Tachikiri in the compound of Taketoyo Station, on the Taketoyo line of the State Railways. Fig. 1 shows the old and new spans turning in a body. The span length was 20 m. (65½ ft.). The whole operation, carried out on July 1, 1931, took only 90 min., of which the actual turning took 3 min.

The diaphragms, trucks and other appliances necessary for the work were manufactured by the Hamamatsu works of the State Railways, the cost being about 2,600 yen per set. Because no powerful jacks were on hand a small staging had to be built to carry the jacks, and accordingly it took a rather long time to do the entire work. It is believed that now, with the staging no longer required, the time can be decreased to 40 min. and the number of workers to 16. Any deck-plate girder not more than 70 ft. in span can be handled exactly in the same way. The equipment is designed so as to stand a total weight of about 70 tons. Therefore the new method will be of great advantage for works on a bridge built very high above the riverbed, but even in the case of a low bridge the saving in cost of replacement comes to about 1,000 yen per 70-ft. span.

Thin Concrete Diaphragm Protects Ringedal Dam

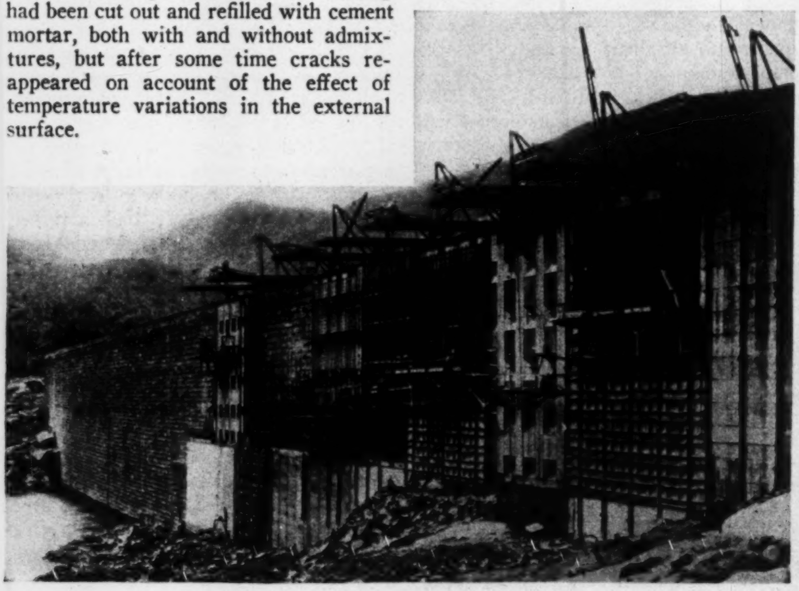
Disintegration of stone masonry due to percolation of water checked by the construction of a watertight diaphragm free of the upstream face of the dam

By Chr. F. Gröner
Consulting Engineer, Oslo, Norway

DISINTEGRATION of Ringedal Dam at Hardanger, Norway, due to percolation of water through its porous masonry, has been effectively checked by the construction of a thin diaphragm of reinforced concrete parallel to but entirely free from the upstream face of the dam. The diaphragm is supported by struts resting against the face of the dam.

Ringedal Dam was built during the period 1912 to 1918. It has a maximum height of 35 meters and a length of 521 meters. The volume is 80,000 cu.m., including a granite facing on the upstream and downstream sides. Portland cement was used in the concrete and in the 1:2 mortar of the joints of the facing. The upstream face of the dam has a southern exposure; its area is approximately 9,800 sq.m.

In recent years a considerable and gradually increasing leakage through the dam has been observed. To insure the safety of the structure, which was threatened by this continuous percolation of water through the concrete, leading to its gradual deterioration, extensive repairs were ordered in 1928, using a method developed by the writer. Previous to that time less comprehensive attempts had been made to repair the structure. Joints in the stone facing had been cut out and refilled with cement mortar, both with and without admixtures, but after some time cracks reappeared on account of the effect of temperature variations in the external surface.



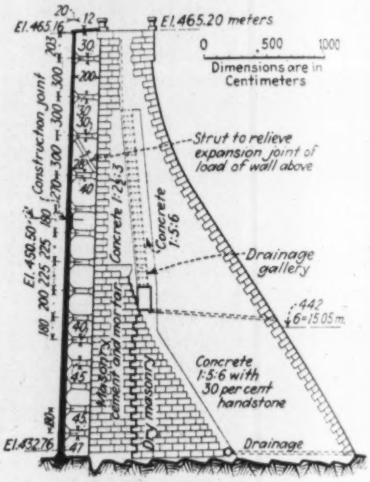
A thin slab or concrete has been built in front of the upstream face of the Ringedal Dam to protect the old masonry from attack by water.

In one section of the dam, approximately 55 m. long, cement grouting was undertaken. This was done very carefully and thoroughly by a company specializing in such work. However, the result was not satisfactory. Percolation of water had left a lining of organic material in the pores of the concrete so that the injected cement did not adhere to the concrete but remained loose in the pores.

In order to investigate the condition of the concrete in the inner parts of the dam, drill cores 130 mm. in diameter and extending from the crest down to a depth of 22 m. were withdrawn and were carefully studied. They showed that the inner part of the dam was, in general, in good condition, but porous. In certain places it had disintegrated, especially at or close above the construction joints and just behind the stone facing on the upstream side. The dam was, however, in sufficiently sound condition to make it a safe support for a waterproof slab above the upstream face. The concrete was characteristic of that used generally fifteen or twenty years ago when even lean mixtures were considered to produce an almost indestructible material and when only simple precautions were taken during construction. Generally, the mixtures were too lean, and at the same time not enough care was taken in grading the materials, in controlling the amount of water, handling the pouring of construction joints and in protecting the concrete during curing. Moreover, in the design insufficient attention was paid to physical properties. The resulting concrete was in general non-homogeneous, porous and with innumerable points open to attack by pure or acidulous water.

Ringedal Lake serves as a storage reservoir for the 110,000-hp. Tysse I hydro-electric power development. The water level is, therefore, variable, and the dam is more or less dry during a great part of the year. The lake usually is full (El. 464.5 m.) from the end of July until the end of October. During the winter the water is gradually withdrawn so that the elevation in January is approximately 15 m. below the crest of the dam and in April is down to the base of the dam (El. 430 m.).

Section of the Ringedal Dam, showing the original structure of stone masonry and concrete and the protective slab built free of the upstream face.



The temperatures encountered in this locality are as follows:

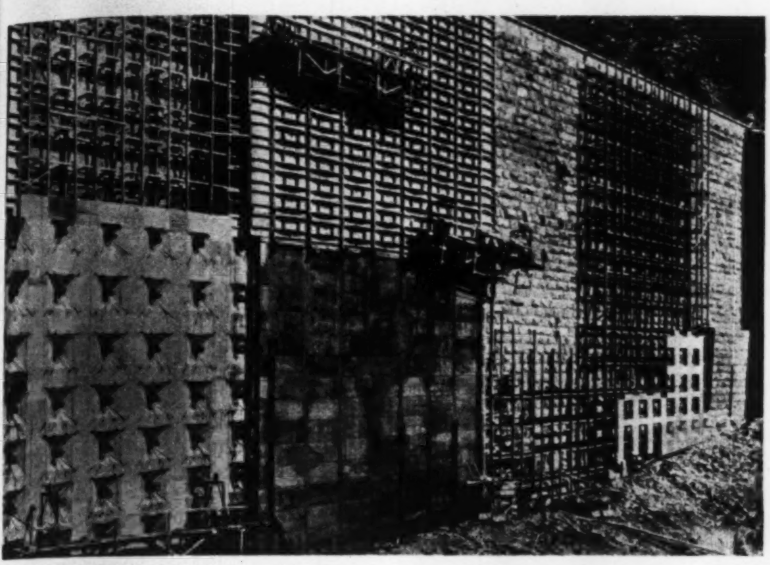
Minimum winter temperature is between —20 and —25 deg. C.

Maximum summer temperature is between +25 and +30 deg. C.

The temperature in Ringedal Lake varies during the year from +2 to +12 deg. C. at depths exceeding 1 m.

The degree of acidity of the water is determined by colorimetric analysis. Averaging 37 tests showed a hydrogen-ion concentration of pH = 5.9. The amount of solid ingredients in the water averages 7 mg. per liter. The percentage of organic material in the solids is small.

At times of low water the dam is exposed to wide temperature variations. In the joints of the stone facing large and small cracks appear, so that the



Unusual care was exercised in constructing the formwork and in placing the reinforcing steel for the protective slab.

water has access to the concrete behind the stone facing; and as the concrete is porous, a considerable amount of water percolates through the dam and disintegrates the concrete.

Since 1925 a systematical record of the leakage has been made. During 1929, for a submerged dam area of 7,300 sq.m., 51,000 cu.m. went through in 24 hours, or on an average of 7 cu.m. per sq.m. per 24 hours; or 0.08 sec.-liter per sq.m. of dam area. In this is included leakage along the base, which might be assumed to be 10-15 per cent of the total leakage.

Protective diaphragm

The reinforced-concrete slab that now protects the old masonry carries the direct pressure of the water and is held 2 m. in front of the dam by struts, as is shown in the accompanying illustrations. The space behind the slab is drained through the dam and makes inspection of the structure possible. In this way any seepage that develops or any structural failure will be immediately evident and can be repaired. Also the original dam is now entirely dry, assuring its stability and permanence. The possibility of the development of uplift also is reduced.

Since the slab will be exposed to both high and low temperatures at time of low water, while the old dam will have very little temperature variation, the slab must be able to expand and contract as much as possible independent of the dam.

The slab is, therefore, supported against the dam by means of slender struts that carry the load over to it. To keep the bending stresses within reasonable limits, the struts, which in this case are rigidly connected to the slab, should have a minimum length of 2.0 m., inclusive of the heads of the struts in the transition to the slab, the length depending upon the distance between expansion joints.

The slab is designed for temperature variations as follows:

±20 deg. C. for the upper part.
±12 deg. C. for the lowest part.
Uniform temperature fall inclusive of shrinkage:
Above horizontal expansion joint, 20 deg. C.
Below horizontal expansion joint, 10 deg. C.
Uniform temperature rise:
Above horizontal expansion joint, 15 deg. C.
Below horizontal expansion joint, 8 deg. C.

The slab and the struts are designed for maximum stresses as follows:

For the slab:
f_c = 40 kg./sq.cm.
f_s = 1,000 kg./sq.cm.
Centric compression in struts: f_c = 35 kg./sq.cm.
Bending stresses in struts:
f_c = 65 kg./sq.cm.
f_s = 1,200 kg./sq.cm.

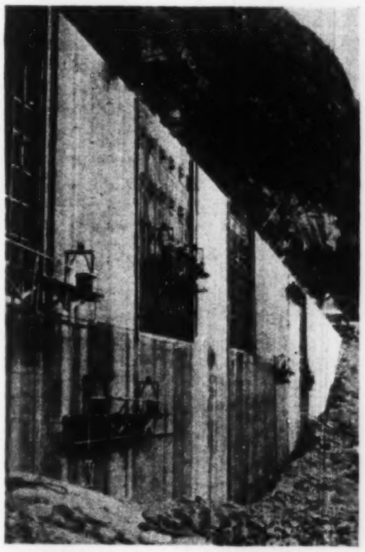
The struts are reinforced with spirals in order to obtain the necessary slenderness for the relatively heavy loads from water pressure. The diameter of the struts varies from 30 cm. for the upper rows to 45 cm. for the lowest rows at 31 m. depth.

If the reactions from the concentrated loads that the struts carry to the dam are considered to be distributed in the dam at 45 deg. to the surface, the pressure will be uniformly distributed at a distance of approximately 90 cm. from it. In other words, at 90 cm. from the surface the pressure will be practically the same throughout the dam as though water pressure were still exerted against the upstream side.

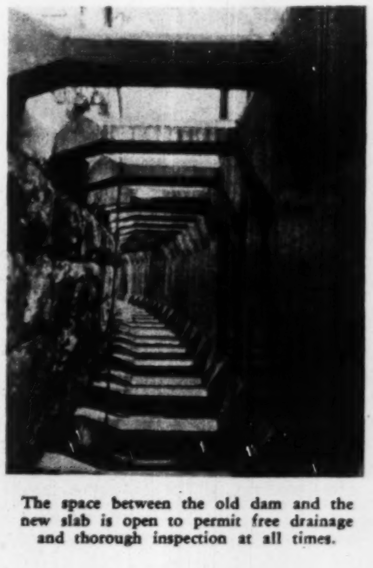
The concentrated reaction from the slab against the dam is, therefore, fully safe, because, when the bolt holes for each strut were drilled the condition of the concrete at the base of each strut was evident and any necessary reinforcement could be obtained by grouting.

The thickness of the slab varies from 20 cm. in the top to 47 cm. at 35 m. depth. The horizontal distance between the struts is 2.25 m., and the vertical distance varies from 3 m. at the upper row of struts to 1.80 m. at the lowest.

The slab is divided into 68 sections by means of one horizontal and 38 vertical expansion joints, altogether 9,700 sq.m. in area. The horizontal expansion joint is approximately 15 m. below the crest of the dam. The distance between the vertical joints varies from 10.5 to 19.4 m., according to the original expansion joints in the gravity dam. There are 1,246 lin. m. of expansion joints. Of these, 659 meters are made watertight with copper plates, and 587 meters utilize bituminous material. The joints are absolutely tight. The most difficult places to obtain watertightness were at the crossings between horizontal and vertical joints. The copper plates have a thickness of 1.5 mm.



Concrete was poured in large sections and as a continuous operation from the rock up to the construction joint and from the joint to the top.



The space between the old dam and the new slab is open to permit free drainage and thorough inspection at all times.

The protective slab is founded on rock and is quite separate from the base of the dam. The space between it and the dam is covered at the top by a slab provided with vault lights. Expansion joints in this cover correspond with the vertical joints in the slab.

Construction operations

Construction of the protective slab was started in 1929. On account of the level of the water in the Ringedal Lake, only 2 to 2½ months each year could be considered for construction under normal conditions, and the work was estimated to be finished in three years. Construction was carried out by the Höyer-Ellefsen Contracting Co.

The granite at the base of the dam is fine-grained. At certain places it has fissures and is fractured, but in general it is satisfactory. Where the rock is solid only the outer surface was blasted away in order to get sound rock upon which to found the concrete slab. The width of the contact plane between the rock and the concrete base (perpendicular to the slab) was approximately 1 m. at 30-35 m. depth. Preparation of this rock base was performed very carefully. Fissures were cleaned out, and the rock was grouted.

Strut construction

To take the tensile stresses that are caused by temperature deformation at time of low water, the struts are anchored to the dam by means of 25-mm. and 32-mm. steel rods. Holes for the anchor rods extend to 1.40 m. behind the stone facing.

During the drilling of these holes a good idea was obtained of the concrete just behind the facing. It was found to be quite dark and contained mud in some places, the cement being partly dissolved so that the sand and gravel were loose. In other places the concrete was solid and satisfactory. The concrete was found to be most porous at the two upper rows of struts.

On account of the heavy loads, which at full water pressure are transmitted from the struts to the dam, grouting was performed at the base of each strut to insure against a displacement of the individual face stones on account of weakened and partly deteriorated concrete behind them. The grouting was done after the bolts were in place so that they were fixed at the same time. For the 1,700 bases 0.48 bbl. per base was required. The pressure used was 110 lb. per sq.in. The grout contained 85 kg. of cement per 40 liters of water.

Sectional forms of dressed tongue and groove boards were used for the slab. Those for the upstream side of the slab were lined with sheet steel in order to get a smooth and even surface, since the slab has no finishing coat.

The mixture in the concrete is the same for the slab as for the struts, *i.e.* 410 kg. cement per cubic meter of concrete. Ordinary Norwegian portland cement was used for all sections but two. For one of these slag cement was used, which consisted of a mixture of at least 15 per cent portland cement (by weight) and 85 per cent basic slag from blast furnaces. The second section was made with moler cement, which consists of 75 per cent ordinary portland cement and 25 per cent moler, which is ground with the cement clinker. Moler is a diatonecious earth, containing approximately 60 per cent pure silica. These two kinds of cement contain comparatively little lime, approximately 50 per cent CaO, while ordinary portland cement contains approximately 63 per cent. In regard to the solvent action of water, these cements, therefore, should be more resistant than ordinary portland cement.

Aggregates produced by crushing

Sand and coarse aggregate were produced by crushing finely grained granite, and were stored in covered silos. The moisture was uniform and, in general, 0.4 per cent of the weight. The amount of water for the concrete mixture was therefore practically constant for the same consistency of the concrete. The water-cement ratio for concrete made of portland cement was 0.52-0.53 (by weight). Last year it was approximately 0.54. The specific gravity of the sand was 2.635 and the average weight per unit of volume 1.58 kg. per cu.cm., or it had approximately 40 per cent voids.

The sand which gave the highest degree of plasticity and workability had a grading (without cement) that was a little below the Fuller curve. With the assumed amount of cement it was about identical with Graf's curve for mortar made of crushed sand. The proportion of the mixture was, by weight, 1:2:2.2, by volume 1:2:2. The maximum diameter of stone was 25 mm., or about 1 in.

For concrete made of slag cement, a water-cement ratio of 0.56 was found to give best results. The initial setting for this cement started in 6 hours and was finished in 10 to 12 hours, while the initial setting for the portland cement started in 3 hours and was finished in 6 hours. The development of heat during the initial setting was considerably lower for slag cement (20 deg. C.) than for the portland cement, where it varied from 30 to 40 deg. C., measured under the same circumstances. The concrete made of slag cement was stiff and not easily workable. It settled during the first couple of hours after pouring and exuded much water. On account of the exudation of water a honeycomb structure appeared at joints and cracks in the formwork. The compressive strength at 28 days was 30 per cent lower than for ordinary portland cement, but the tensile strength was the same.

By using moler cement the most plastic consistency and the most workable concrete were obtained with a water-cement ratio of 0.65. The initial setting started in 1½ hours and was finished in 6 hours. The development of heat during the initial setting was approximately the same as for portland cement. Contrasted with the slag cement, the moler cement did not segregate during pouring, and in this way it was superior to the portland cement. The compressive strength at 28 days, with a water-cement ratio of 0.65, was about the same as for portland cement with a water-cement ratio of 0.53, being on the average 315 kg. per sq.cm. in cylindric forms 15 cm. in diameter and 30 cm. high.

All sections of the slab were poured continuously from the bottom up, without stopping longer than one hour for placing a new section on top of the outer formwork. In this way poured joints were avoided. The inner side of the formwork and the reinforcing bars were already placed for each slab section before the pouring was started. Usually two sections were poured at the same time so that the carpenters and the pouring crew changed sections and could work without interfering with each other.

Laboratory control

Thorough control over the concrete was maintained by a laboratory at the mixing plant, where compression, tension, bending and absorption tests were made on concrete taken directly from the mixer. For the tension and bending tests the stone was sifted out on account of the small dimensions of the forms. All tests were made at the work, except permeability tests, which were done at Dalen portland cement factory.

The first third of the slab was completed in 1929, covering 151 m. of the length of the dam. The end section was closed off in the fall and the space behind the slab was emptied. The second third was completed in 1930, covering a length of 140 m. and was put into service in the fall of that year. The last third was completed in 1931, covering 184.3 m. of the length of the dam. The two sections first completed have been in service for 2½ and 1½ years, respectively, and the last third section for one-half year. The slab covers an area of 9,700 sq.m. and is absolutely watertight. The expansion joints are likewise tight, and the structure, which several times has had full water pressure and has been exposed to high and low temperature at depleted water level, has worked quite in accordance with assumptions and calculations.

The Ringedal Dam is the property of A. S. Tyssefaldene, Oslo, Norway. The plans and design for the diaphragm were prepared by the author. Thor G. Brandtzeg, New York City, was the resident engineer on construction. A. S. Höyer (Ellefsen, Oslo, Norway) was general construction contractor.

Grand Trunk Relocation on Detroit-Pontiac Line

State pays for land and construction, to be repaid in 15 years—Heavy grading and numerous bridges—Electrification planned

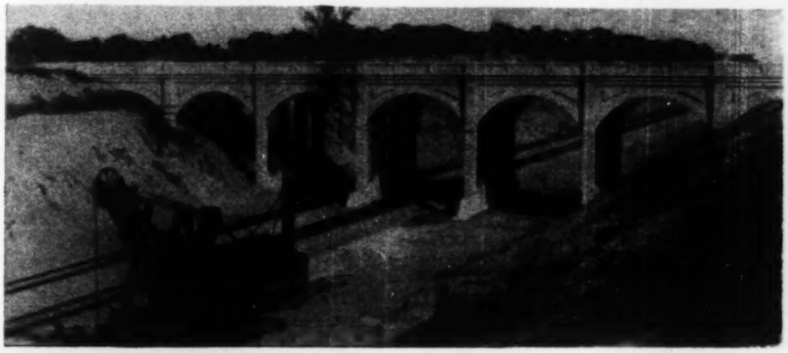
Relocation of 9 miles of railway on a new right-of-way provided by the state, with grade reduction, grade separation, eighteen bridges, heavy cuts and fills and extensive landscaping through residential districts are among the interesting features of an improvement now completed on the Grand Trunk Western Ry. between Detroit and Pontiac, Mich. Filling sink-holes and terracing deep cuts were unusual items in the grading. Provision for four tracks, high-speed suburban service and possible electrification of the 26-mile line are other items of special interest. This $7,000,000 improvement was initiated mainly in order to permit the construction of a super-highway, whose widening to 204 ft. will encroach on the railway's old right-of-way.

—Editor.

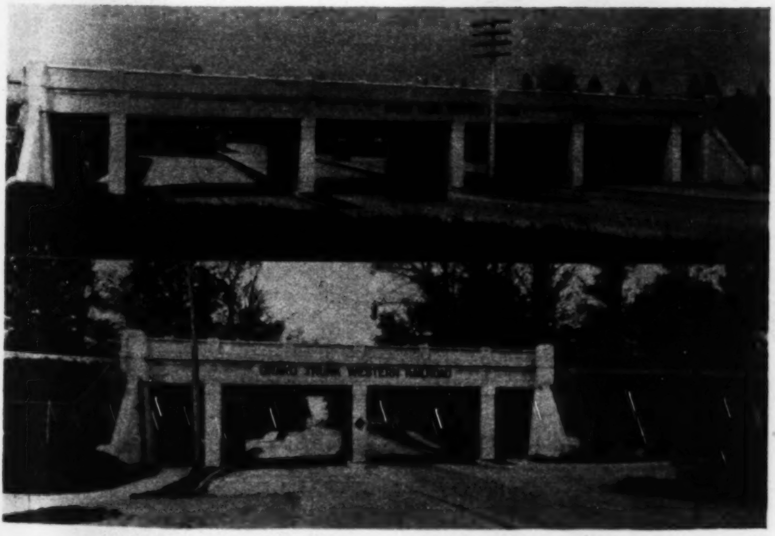
A STATE HIGHWAY project for widening Woodward Ave. as a 204-ft. super-highway between Detroit and Pontiac, Mich., was the initial cause of the relocation of 9 miles of the Detroit division of the Grand Trunk Western Ry., but the improvement has included numerous works accessory to the mere relocation. For several miles the railroad right-of-way adjoined the east side of Woodward Ave., so that relocation of the line was necessary before the widening could be undertaken. As the territory between Detroit and Pontiac has been highly subdivided and partly built up as a residential district, the general policy of the improvement included: (1) complete elimination of grade crossings, (2) provision for marginal highways to facilitate traffic affected by street closing, (3) landscaping along the new right-of-way and (4) development of fast suburban railway service. This improvement supplements the extensive grade separation of the Grand Trunk Western R.R. in the city of Detroit, as described in *Engineering News-Record* of July 10, 1926, p. 60. Work was begun in 1928 but was interrupted for one year by litigation, the line being opened officially on Aug. 1, 1931. The cost of the relocation was about $7,000,000.

Under the original charter of the Detroit & Pontiac Ry., built in 1838-1843, the taxes paid by its successor, the Detroit, Grand Haven & Milwaukee, later acquired by the Grand Trunk Western, have been based upon a fixed percentage of the capital stock. In recent years the state of Michigan has sought to have this charter surrendered and the railroad reincorporated under the present general railroad law, by which taxes would be charged upon the value of the property. As the special charter was upheld by the supreme courts of Michigan and the United States, it played an important part in the negotiations for the relocation of the railroad.

The most important section was the stretch of line from Royal Oak to a point 3½ miles north of Birmingham, Mich., where the railroad was parallel with and adjacent to Woodward Ave. Relocation was first considered 26 years ago, as encroachments on the right-of-way had limited the line to a single track and there was no possibility of increasing the railroad facilities. But the cost was prohibitive, and the matter rested until 1923, when the state legislature passed a bill to finance the widening of Woodward Ave.



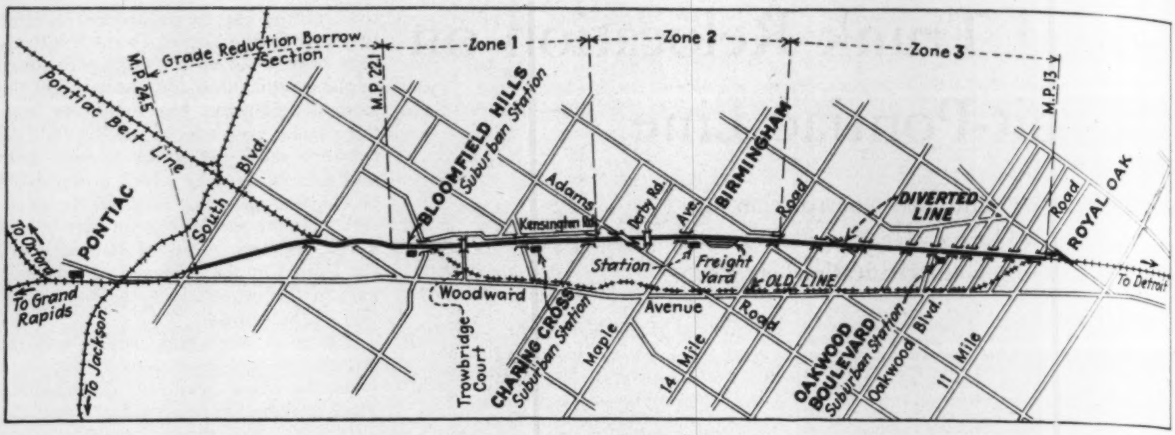
Where Trowbridge Court crosses a deep cut the long columns of the viaduct are braced by spandrel arches.



Bridges of two 20-ft. spans are typical of those used in the Grand Trunk Western grade-separation work, as in the Catalpa Ave. crossing here shown. For Oakwood Boulevard, a super-highway, four spans of 28 ft. are employed.

As this improvement necessitated acquisition of the railway right-of-way, negotiations resulted in 1927 in an agreement by which the state undertook to finance initially and to acquire a new right-of-way for the railroad, approximately ¾ miles east of the original location and extending from mile-post 13 at Royal Oak to mile-post 22, north of Birmingham. It also undertook to finance the initial cost of: (1) grading a double-track roadbed, (2) constructing grade separations at certain streets, (3) constructing a single-track main line and reproducing the other track facilities on the old line, (4) reproducing the equivalent buildings, telegraph lines, water facilities, signals, etc., as existing on the old line. Furthermore, the state agreed to bear the cost outright of all additions and betterments in connection with the highway work, including parallel roads along the right-of-way, while if additional grade separations were required, each party would bear 50 per cent of the cost.

On its part, the railroad undertook to return to the state the cost of land and construction (except for those parts of


Grade Reduction Borrow Section
M.P. 24.5
M.P. 22.1
Zone 1
Zone 2
Zone 3
M.P. 13
Pontiac Belt Line
PONTIAC
To Oxford
To Grand Rapids
To Jackson
South Blvd.
BLOOMFIELD HILLS Suburban Station
Adams
Kensington Rd.
Derby Rd.
Ave.
BIRMINGHAM
Road
DIVERTED LINE
ROYAL OAK
Road
To Detroit
Station
Freight Yard
OLD LINE
Woodward
Avenue
Road
Trowbridge Court
CHARING CROSS Suburban Station
Maple
14 Mile
OAKWOOD BOULEVARD Suburban Station
Oakwood Blvd.
11 Mile

To permit the widening of Woodward Ave., the line of the Grand Trunk Western has been diverted to a new right-of-way acquired by the state. Minor streets are not shown in this plan.

which the state agreed to bear the cost outright) by annual payments during fifteen years, without interest. It also undertook to bear the entire cost initially and outright of additions and betterments beyond those covered by the agreement. Finally, it agreed to surrender its special charter at the end of the 15-year period and to reincorporate under the general railway laws of the state. It was further provided that all planning and engineering supervision should be under the direction of the chief engineer of the railroad, subject to approval by the state highway commissioner, while these officials would act jointly in the purchase of land and letting of contracts. All property was acquired in the name of the state, to be deeded later to the railroad company. Agreements with the various local municipalities covered approval of the designs and also provided 15-ft. easements parallel with and adjoining the right-of-way, which were granted to the communities for planting trees and shrubbery to screen the embankment in the residential districts.

Location and grading

Between 1922 and 1928 several locations were studied. The adopted line is 8.82 miles long, or 0.28 mile shorter than the old line. It is all on tangent except for a 15-min. curve at Birmingham and a 2-deg. curve running into the old line at the north end, the curvature per mile being 15 min. as compared with 2 deg. on the old line. The maximum grade is now 0.65 per cent instead of 1 per cent.

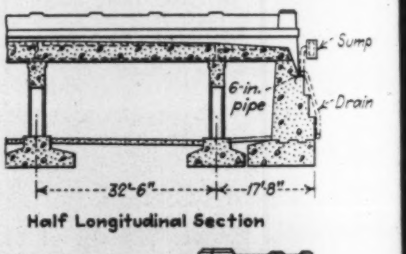
From Royal Oak to Birmingham, 5 miles, the roadbed is on a fill averaging 14 ft. in height, so that there is a minimum of street excavation at the crossings. Beyond Birmingham there is rolling country and the cuts have an average and maximum depth of 20 ft. and 50 ft., respectively. All cuts and fills were constructed for four tracks, but at present only two tracks have been laid. The grade reduction extends 2½ miles beyond the relocation to Pontiac, the new roadbed being cut alongside the old one, with an average difference of 24 ft. in elevation. This part of the work was complicated by heavy traffic on the existing line.

For the control of grading operations, rather than the balancing of yardage, the project was divided into three zones, with a total of 1,750,000 cu.yd. of excavation. Zone 1, extending south 3 miles from the end of the new line, required 710,000 cu.yd. of fill, while the excavation from cuts and street lowering amounted to 530,000 cu.yd. The additional 102,000 cu.yd. of fill was furnished by the grade-reduction cut on the old line into Pontiac. A sink-hole complicated matters by requiring an extra 100,000 cu.yd. before a stable fill could be obtained.

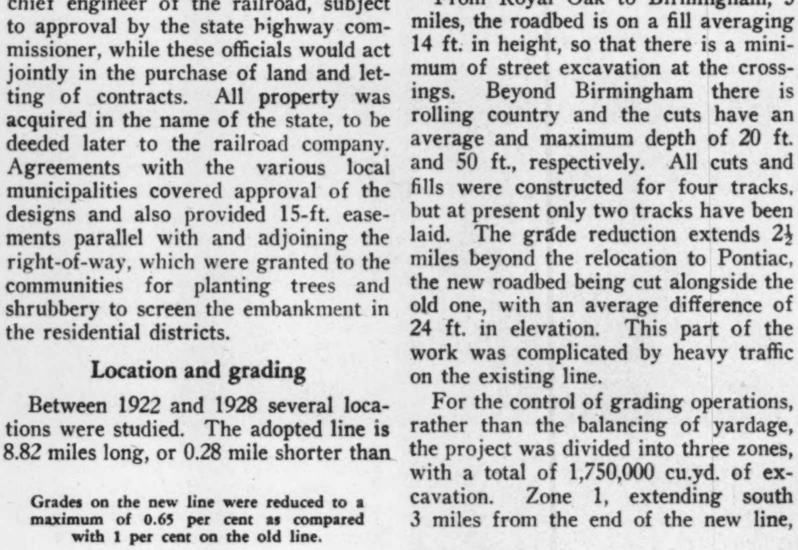
Zone 2, 2¼ miles, involved 290,000 cu.yd. from cuts and 46,000 cu.yd. from street lowering. As the fill was only 300,000 yd., the excess material was used in Zone 3 and for grading a new freight yard at Birmingham. Zone 3, 4 miles, required 640,000 cu.yd. for continuous fill, but street excavations provided only 110,000 yd., the remainder being obtained from the grade-reduction cut at Pontiac. Thus the haul for this zone exceeded 9 miles, while in the other zones it was relatively small.

The deepest cut was 50 ft., on the

The bridge over Maple Ave. is typical of the structures used at ordinary street crossings.


Sump
6-in. pipe
Drain
32'-6"
17'-8"
Half Longitudinal Section
Stairway to station
Expansion joints
80'
Half Section, Sidewalk Span
5'-4"
3'-8"
14'
75'
4'-9"
Half Section, Roadway Span

Grades on the new line were reduced to a maximum of 0.65 per cent as compared with 1 per cent on the old line.



grade reduction north of the new line, this section also having the highest fill, averaging 40 ft. for a length of 6,500 ft. On the new location the deepest cut was in Zone 1, averaging 40 ft. for a length of 2,000 ft. Cuts are drained by open ditches and subsurface drains of concrete pipe are laid with open joints in trenches backfilled with bank-run gravel. The size of pipe varies with the length of cut and with the amount of flow estimated from a year's observation of the drainage during construction.

Sink-holes cause trouble

In this locality glacial action has formed bowl-shaped depressions filled with unstable material composed of decayed vegetation and in general covered with overburden solid enough to conceal them. A sink-hole 400 ft. long in Zone 1 completely wrecked the construction trestle when 15 ft. of fill dropped, forcing out the underlying muck at the sides. The fill was completed by raising the track on successive dumps until a solid base was reached. Two sink-holes about 300 ft. long and 27 ft. deep occurred in the deep 9,200-ft. cut south of Pontiac. All the muck was removed from these, and 11,000 cu.yd. of stable material was used in backfilling.

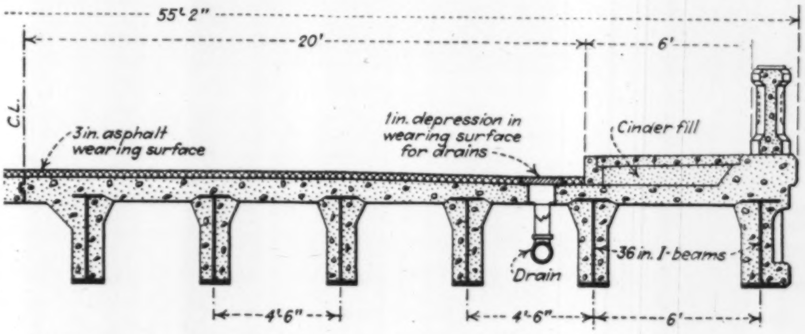
Terracing was adopted in the deep cuts in order to minimize sliding or sloughing of the slopes.

Since 85 streets were crossed and no grade crossings were permissible, the location of grade-separation structures had to be studied carefully in order to provide adequately for the highway traffic. The selection was influenced by the master plan system of highways for Detroit and its environs. Besides fifteen railroad bridges and three highway bridges, seventeen marginal highways and numerous street diversions were constructed to connect closed streets with those having bridges.

The railroad bridges conform to a general type developed by the Grand Trunk Western Ry. for its grade-separation works in various cities. Their architectural treatment is simple, with plain copings and fascias, paneling being used sparingly and pylons for the hand-railing providing a finish for the abutments. Sidewalk bents are used in all cases, and the sidewalk width averages 7 ft. Box abutments, combining the abutment wall and sidewalk bent, were used at one bridge.

Abutments and wing walls are of the stepped gravity type, except where the height necessitated the counterfort type of construction. The roadway units were designed to provide single 28-ft. roadways or double 20-ft. or 28-ft. roadways, as required. At Oakwood Boulevard, or Twelve-Mile Road, four 28-ft. roadways were provided for a future super-highway 204 ft. wide.

All the bridges have ballasted decks, the spans consisting of I-beams embedded in concrete, with a maximum depth of 4½ ft. from base of rail to underclearance. The only variation from the standard type was at a bridge on 30 deg. skew, where the span length necessitated half-through plate girders with shallow floor beams cased in concrete. All bents are of the arched type, the columns resting on inverted T-beam footings, which are usually founded in hard clay. Plastic clay at one bridge necessitated piling; quicksand at three others required deep footings; large sewers in some cases required steel sheetpiling and other special construction. The bridges were built for four tracks and a minimum highway headroom of 14 ft. Depressed highway approaches have maximum grades of 4 per cent, with vertical curves averaging 400 ft. long in the sag and 100 ft. at intersection with the normal street surface.

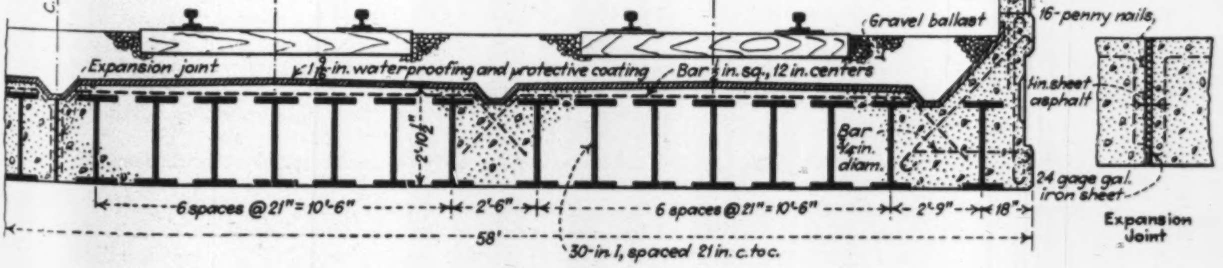

55'-2"
20'
6'
C.L.
3 in. asphalt wearing surface
1 in. depression in wearing surface for drains
Cinder fill
Drain
36 in. I-beams
4'-6"
4'-6"
6'

Deep I-beams incased in concrete were used to carry the roadway slab of Adams Road. a skew crossing.

Standard construction could not be applied to the three highway bridges. As the Trowbridge Court bridge, with seven 33-ft. spans of reinforced concrete, crosses the 50-ft. cut, the unsupported height of columns was reduced by means of spandrel arches. In the end spans a half arch runs into a horizontal girder extending to the abutment. Continuous T-beam and slab construction was used in this bridge and the Derby Road bridge, each of which has a 30-ft. roadway and two 5-ft. sidewalks. The Adams Road bridge, with five 56-ft. spans, is on a skew of 35 deg., and as it required long approach fills, the depth of floor was reduced by using I-beams cased in concrete and carrying an 8-in. deck slab. This bridge has a 40-ft. roadway and 6-ft. sidewalks.

For drainage from the deck and backfill of the railway bridges, three catchbasins placed between the tracks at each end of the bridge are connected to a 6-in. perforated galvanized pipe laid on the first bench of the abutment. Vertical 6-in. galvanized pipes lead thence to a drain of concrete pipe laid above the footings and connected with a street catchbasin.

To determine the efficiency of the upper horizontal drain, the pipe was extended beyond the fill at some of the bridges. During both a severe short rainfall and a prolonged heavy rainfall, which ordinarily would tend to saturate the ballast and backfill, it was observed that this pipe carried a considerable flow and so prevented the building up of hydrostatic pressure in the backfill behind the abutment. During intermittent rainfall this pipe appeared to be of little



Closely spaced I-beams were used for the roadway spans to keep the slab thickness as small as possible.

use, as the porous character of the backfill enabled the water to flow directly to the lower drain pipe.

Stations and yards

For the residential village of Birmingham, Mich., an attractive passenger station has been built, with a tunnel serving stairways leading to the platforms, while a separate tunnel serves the baggage elevators. A concrete plaza provides for automobile parking. South of the station is an industrial development intended to accommodate industries that were located on the old line. Here are provided a fifteen-track freightyard, a teamyard with concrete driveways and a freighthouse with two house tracks. Passenger facilities provided at three other points for the suburban commuter service include concrete platforms 400 ft. long, steel shelter sheds and steel stairways to the street level. As small passenger stations will be built at these places later, tunnels for future platform stairways were built during the construction of the line.

Miscellaneous work

In consequence of the district traversed being heavily built up, considerable work was required for the protection of sewers, water mains and other public utilities. Many of the larger sewers crossed were protected by concrete arch saddles, while water mains and the smaller sewers were cased in concrete. But in many cases the old lines were abandoned and new sewers and mains built on different routes. This work was undertaken in adance of grading and constituted one of the major projects.

After grade separations had been completed, paving and sidewalks were relaid. House services were replaced, and the side slopes of street approaches were sodded. In the aim to restore or even improve the original conditions, the railroad had cooperation from the city engineers and local authorities of the several municipalities.

The new tracks are laid with 100-lb. rails of A.R.E.A. section on creosoted ties, fully tie-plated and carried in washed and screened gravel ballast. Automatic signals of the three-position color-light type have been installed for the entire distance between Detroit and Pontiac. As the latter city is a manufacturing and automotive center, served by three divisions of the Grand Trunk Western, the company undertook the construction of a belt line to provide better interchange of traffic. This belt line connects with the relocated main line about 1½ miles south of Pontiac.

Construction methods

Fills were made by dumping the core from temporary pile trestles, the material being hauled on narrow-gage tracks by 5-yd. air-dump cars and gasoline locomotives. Only the caps and stringers of these trestles were recovered. Widening the fills and handling the long haul of material from the deep cut at the north end of the line was done by 12-yd. air-dump cars and steam locomotives, with track plows or spreader cars to level the dumped material. For miscellaneous hauling, including material from street excavations, motor trucks were used, depositing the material in the fill with minimum haul. Steam shovels ranged from ¾-yd. machines for the lighter work to 3-yd. machines in the heavy cuts. A 6-yd. dragline machine was used on the north cut alongside the old line, where it was necessary to maintain the hauling track on the upper level.

A concrete plant was established at each bridge. Field control included proportioning by the water-cement ratio, analyses of aggregates, slump tests and the taking of test cylinders. For the footings and neat work of gravity abutments and wing walls, a nominal 1:2½:5 mix was used, with a minimum of 7 gal. of water per sack of cement. For reinforced concrete and the footings and neat work of bents and deck slabs, the nominal mix was 1:2:4, with 6½ gal. of water per sack of cement. When concreting at temperatures below 50 deg. F., the aggregates and water were heated and the concrete in place was protected by a tarpaulin inclosure in which the temperature was kept at 60 deg. by steam heat for seven days. During this period the concrete was wetted thoroughly each day, so that in effect the inclosure was a moist chamber for the curing of concrete. Full sections between expansion joints were completed in each pouring. A smooth and even finish was obtained by stripping the forms as soon as practicable and rubbing the exposed surfaces with carborundum blocks. A smooth floated finish was given to the decks of all the bridges.

A waterproofing membrane for the bridge decks consisted of two plies of cotton fabric saturated with asphalt and laid with a concrete priming coat and three moppings of hot asphalt. This membrane was protected on level surfaces by a 1¼-in. coat of rolled asphalt-sand mastic. On the sloping inside face of the fascia girders, asphalt plank was laid, having a molded end that was tucked into a groove in the concrete at the ballast line. Both the membrane and protective coating are carried down over the bridge seat joint to a seat provided 18 in. below on the back of the abutment. The backs of all walls and abutments were given a priming coat and two hot moppings of asphalt mixed with asbestos.

Engineers and contractors

The principal contractors were as follows: grading, H. W. Nelson Co., New York, N. Y.; bridges, A. Guthrie & Co., St. Paul, Minn.; paving and sewer work, R. D. Baker Co., Royal Oak, Mich.; station at Birmingham, Walbridge-Aldinger Co., Detroit, Mich. Tracklaying was done by railroad forces. This entire project was planned, designed and executed under the direction of J. A. Heaman, until recently chief engineer of the Grand Trunk Western, with F. P. Sisson as principal assistant engineer, A. N. Laird bridge engineer, and H. D. F. Ingram field engineer in charge of construction. The final negotiations and settlements with the state of Michigan, local municipalities and some of the contractors will be directed by P. D. Fitzpatrick, who has recently succeeded Mr. Heaman as chief engineer of the Grank Trunk Western.

Eight-Year-Old Sewage Plant Produces Satisfactory Effluent

TIME was when an eight-year-old sewage-treatment plant was considered ancient, and gave indifferent results at best. In present-day practice, however, a well-maintained plant can still be highly satisfactory in its service. Reports of the working of the plant operated by the Urbana and Champaign (Ill.) Sanitary District bring out the detailed facts of a typical case.

During the year ended April 30, 1932, this plant effected a removal of 82 per cent of the suspended matter and a 95 per cent reduction of the b.o.d. (biological oxygen demand). The per-capita operating cost was 36c., a reduction of 1c. from the previous year. Including interest, bond service and other corporate expense, the cost was $1.54 per capita.

The district was organized in 1921 and its plant went into operation in 1924. The plant consists of coarse screens, four Imhoff tanks, twelve sludge-drying beds, one lagoon sludge-drying bed, 1.6 acres of trickling filters and a secondary settling tank with a lagoon stand-by unit for secondary treatment. Operating data follow:

Screens were cleaned four times per day; the screenings (38.5 cu.yd.) removed from the 1,059 m.g. of sewage were sprinkled with lime and buried. Grit removed amounted to 21 cu.yd., twice as much as last year.

The four Imhoff tanks treated an average of 2.9 m.g.d., the highest being

7.1 m.g.d., making the average retention period 2.2 hours. An average of 57 per cent removal by the tanks of the suspended matter was obtained, and the b.o.d. reduction was 42 per cent. Twice as much scum, 870 cu.yd., was removed from the vents as was removed last year. A 4-in. diaphragm pump, used last year to remove scum, was again satisfactorily utilized. After drying on the sludge beds the scum is used for filling, as it is not recommended as a fertilizer. It produces no marked odors. All sludge drawn was well digested, dried out quickly and had no pronounced odor. The cost has been reduced from 41c. per cubic yard to 30c. The sludge contained an average of 2.7 per cent nitrogen and 90 per cent moisture. Farmers and gardners removed the entire sludge output at no cost to the district, which assumes no responsibility in its use as a fertilizer.

No excessive pooling on the surface of the stone sprinkling filters has been experienced. A 6-tine pitchfork is used to turn the stone near the nozzles when pooling occurred. Flies have not been extremely offensive. A dozen nozzles per day are cleaned. Nitrification was 14.5 p.p.m. last year against 12 p.p.m. for this year Monthly averages range from 20 to 7 p.p.m. The filters remove 74 per cent of the suspended solids down to 53 p.p.m. B.o.d. is 92 per cent removed by tanks and filters combined.

Snails (*Physa anatina*) grow in abundance; the operators would like to learn of their presence elsewhere, as they are not indigenous to the region.

A lagoon adjacent to the secondary settling tank, and receiving the partial flow from it, has been successfully used to propagate fish. For four years fish have lived in the effluent. Examined by the biological department of the University of Illinois the fish showed no signs of parasites in any organ or part.

The average dissolved oxygen content of the stream into which the effluent is discharged shows 10.4 p.p.m. above and 8.9 p.p.m. below the point of discharge; b.o.d. was 5.4 above and 5.6 below. No unpleasant conditions nor sewage deposits have developed in the stream.

Gus H. Radebaugh is manager of the plant, and Pearse, Greeley & Hansen are consulting engineers.

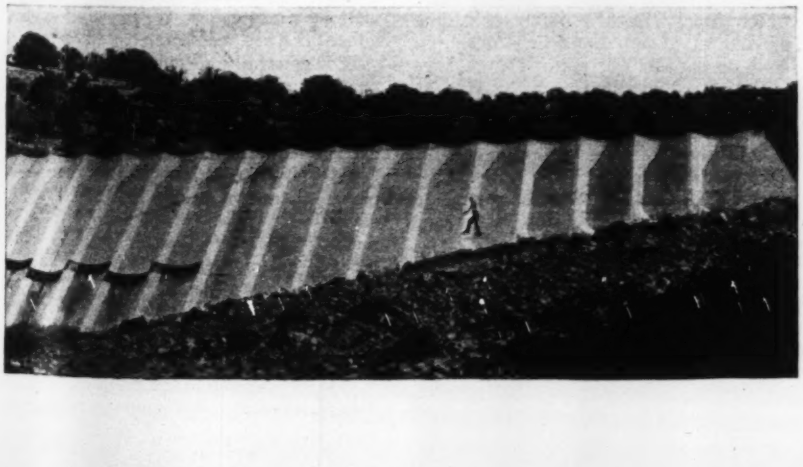
Letters to the Editor

Steel-Faced and All-Steel Dams

Sir—In a letter protesting against the use of steel-plate facings for rockfill dams (*ENR*, July 28, 1932, p. 761), M. M. O'Shaughnessy declares: "More than twenty years ago a number of such dams were built in Arizona along the line of the Santa Fe Railway, which invariably became crippled due to the expansion and contraction of the steel with the changes in temperature."

If steel facings on rockfill cannot stand temperature-change strains, what would one expect from the all-steel dams, exposed in every part, built more than 30 years ago? One of two that I remember was subjected to the heat of Arizona and the other to the cold of Michigan. The Ash Fork dam (Arizona) was built in 1897 or '98 by the Santa Fe Railway, to supply water to its locomotives and to the village of Ash Fork. The Red Ridge dam was built a few years later to supply water to copper stamp mills at Red Ridge, Mich. (See *Engineering News*, May 12, 1898, and Aug. 15, 1901.) The steelwork at Ash Fork was 46 ft. high and 184 ft. long, while at Red Ridge the height was 74 ft. and the length 464 ft.

As happens with so many novelties of engineering construction, these dams were described when built and then forgotten. What has been their subsequent fate? So far as I am aware nothing about the Red Ridge dam has been published since its completion more than 30 years ago. We are better off as to the Ash Fork dam, but its printed record stopped 18 years after the dam had been put in service (*Engineering News*, June 1, 1916, p. 1035).


The steel dam at Ash Fork is still in good condition after more than 30 years of service.

Besides the Ash Fork and Red Ridge dams I remember only one other all-steel dam: Hauser Lake, across the Missouri River near Helena, Mont. This dam, which was 70 ft. high, 630 ft. long and on concrete foundations, failed April 14, 1908, soon after completion. The failure was attributed to faulty foundations. (See *Engineering News*, Nov. 14, 1907, and April 30, 1908.)

Minor though it may be, the all-steel dam forms an interesting chapter in the history of engineering structures. If any all-steel dams other than the three I have named were ever built, in America or elsewhere, they should be put on record, together with the later history of the Ash Fork dam and the fate of the Red Ridge dam. Unless done soon, it never will be done, and this chapter of engineering history will remain incomplete. M. N. BAKER.

Upper Montclair, N. J.,
Aug. 15, 1932.

* * *

Sir—Mr. Girand sends me the letter that follows this one and asks if his statements concerning the dams along the line of the Santa Fe Railway and the Ash Fork dam are correct, and if so, that I add a letter to this effect and mail it with his letter to you. In accordance with his request I can only confirm his statement relative to the dam built for the Santa Fe Railway. It has been in use from the time built until the present. Owing to lack of rainfall it is only at times full of water, but the dam has served the purpose for which it was built. W. B. STOREY,

President, The Atchison, Topeka and
Santa Fe Railway System.

Chicago, Ill.
Aug. 26, 1932.

* * *

Sir—M. M. O'Shaugnessy, of San Francisco, in his letter published in your issue of July 28, 1932, says: "As an advocate of the construction and use of legitimate rockfill dams, I must protest against the use of steel for this purpose. More than twenty years ago a number of such dams were built in Arizona along the line of the Santa Fe Railway, which invariably became crippled due to the expansion and contraction of the steel with the changes in temperature."

I am in perfect agreement with Mr. O'Shaugnessy's first statement but must challenge the accuracy of the last. To my knowledge there is not a single rockfill dam along the line of the Santa Fe Railway in Arizona. The only dam with a steel face is the one built by the railway near Ash Fork, which is a steel structure throughout.

I was connected with the engineering department of the railway at the time this dam was built and inspected it frequently during its construction. Its design was similar to that of the Hauser Lake dam, which failed on account of faulty foundation construction.

Several months ago I took occasion to examine the Ash Fork dam and was agreeably surprised at the state of preservation in which I found this structure. The accompanying view, taken at the time of my visit, shows the appearance of the dam. Careful inspection of the dam failed to reveal that it had ever been cripped, or that any unusual expenditures had been made for its maintenance, except that of keeping it painted, a necessary thing to do in any steel structure. I believe the dam is still in use by the railway, although there was little water impounded at the time of my visit, but this was undoubtedly due to the drought then prevailing.

In my opinion a rockfill dam, under most any condition where the foundation material will support the mass of rock without undue settlement, is the safest and most economical type of dam that can be built. This is particularly true when settlement and earthquake shock are taken into consideration, and surely they should be seriously considered.

That this particular type of dam has not met with more approval by engineers is, in my opinion, due to the fact that most of those built with the concrete waterproof facing directly attached to the rockfill, as Mr. O'Shaugnessy describes, have invariably become crippled due to the expansion and contraction together with the settlement in the main rockfill.

Mr. O'Shaugnessy says, referring to the Morena, Dix River and Salt Spring dams, "The facing of none of these dams has failed." What does Mr. O'Shaugnessy call a failure? The Salt Springs dam is of recent construction, and great pains and expense were resorted to in placing a thick bed of derrick-placed masonry or boulders under the concrete diaphragm. It is impossible to predict at this time what will occur to this concrete diaphragm when full settlement takes place, but in the case of both the Morena and the Dix River dams isn't it a fact that both have experienced difficulty occasioned by the fact that the concrete was attached directly to the rockfill, and settlement and sliding on the steep face caused distortion and rupture, and a considerable expenditure was necessary to recondition these structures? And isn't it barely possible that the end is not yet in sight?

Engineering News-Record of Nov. 5, 1931, published the description of a rockfill type of dam which I had designed to meet the exacting conditions of an earthquake locality, wherein I got away from the defect of attaching the concrete waterproof diaphragm to the rockfill by interposing a bed or layer of river gravel between the flexible concrete facing and the rockfill, which method of construction eliminates buckling and distortion of the slab, either through earthquake waves or settlement of the rockfill.

Phoenix, Ariz.,
Aug. 22, 1932.

JAMES B. GIRAND,
Consulting Engineer.

Timely Warning on Model Tests

Sir—Professor O'Brien's paper, "Analyzing Hydraulic Models for Effects of Distortion," is very timely. The engineering profession seems to be going "hog wild" on model tests, with scarcely a thought to their limitations. On small-scale models where water becomes so shallow that "streamline flow" is likely to occur, the simple expedient has been adopted of distorting the vertical scale. This, however, in many cases has introduced errors, the magnitude of which is uncertain. The author has shown that such distortion is not permissible whenever horizontal and vertical dimensions of prototypes are related by definite laws.

His analysis of the position of critical flow with reference to the end of the flume is applicable to free flow over all broad-crested weirs, as well as to any conduit other than rectangular where critical flow is likely to occur. The flow in such conduits cannot be treated as that in a unit width of a wide channel.

The author did not explain the cause of the drop in pressure head on the channel bed as the end of the flume is approached. It is due to the fact that the water loses weight in proportion to its vertical acceleration. An analysis of this condition of flow was made by S. Woodward in *Technical Report VII*, p. 135, Miami Conservancy District, with, however, an entirely different objective than that prompting the author's analysis.

J. C. STEVENS,
Consulting Engineer.

Portland, Ore.,
Sept. 21, 1932.

Most Waterworks Claimed to Be Self-Supporting

Sir—On the cover page of your issue of Sept. 22 appears the following: "The most significant development in a generation confronts waterworks management today—a change of municipal water supply from a partly subsidized service to a self-supporting business." And on p. 346 the editor's note says: "In theory, municipal water systems are self-supporting, but in practice many of them fall far short of that condition."

One finds, in part, the supporting arguments upon which the above statements are based in an article on p. 336 by Malcolm Pirnie. Mr. Pirnie contends, under three headings, that: (*a*) "Political control leads to insolvent operation;" (*b*) "Taxes are used to pay deficits caused by inadequate charges;" and (*c*) "Tax-secured bonds discourage self-supporting operation."

Although Mr. Pirnie's statements may be an accurate description of the facts as related to some water plants, to accept them as generally applicable to municipally operated waterworks seems unwarranted.

Much might be said regarding the shortcomings of municipally operated waterworks from the standpoint of records and accounting, but, in the writer's experience, when all facts are fairly considered, municipal waterworks are more commonly "subsidizing" than "subsidized." More generally than otherwise they meet all charges arising out of operation and bonded indebtedness, after giving away much "free" water and fire protection. Actually, many municipal waterworks are more than self-liquidating. Under the rates that have heretofore prevailed capital assets have been built up through extensions paid out of earnings, in many instances in excess of bonded indebtedness. In fact, in some instances waterworks earnings are actually diverted to other municipal purposes.

As an offset to the illustration given by Mr. Pirnie, the writer would refer to what he believes to be a more typical instance of municipal operation. In this case the original plant was started by private owners and likewise "after long discussions" was purchased by the municipality at a fair figure. That was fifteen years ago. Today the plant has been increased to about three times its size at purchase. Rates in the interim have been reasonable including fire service, which has been paid for out of the tax budget, and capital assets have been created in excess of bonded indebtedness of about $1,000,000 in a town of about 30,000 population. Is it possible that a "recasting of mental habits is necessary" in that community to make it eligible for an R.F.C. loan?

Yet, as E. B. Black points out on p. 347, "The stipulation that the project shall be self-liquidating through rates and not through taxation will mean a general overhauling of the rate structure in a majority of publicly owned waterworks systems." Does this mean that any community borrowing money from the R.F.C. for waterworks purposes must so "recast its mental habits" that its rate schedule shall *not* include a charge for "free" water and fire protection, the moneys to pay for which must, perforce, come out of taxes.

It is generally accepted that few communities now pay to their water departments an adequate sum for fire protection. And, if this payment alone were made adequate, in how many instances could the contributions to the water department, out of taxes, be shown to be excessive? The proposition that a municipally owned water plant should be self-liquidating without a proper charge to the taxpayers for necessary municipal service is untenable and poor business. And the assumption that a municipal plant is not self-supporting because payments are made out of the tax budget in connection with bond issues may be unfounded unless proper allowances are made for "free" municipal service.

But, in any event, in view of the claim of the editor that generally municipal waterworks are "partly subsidized" and that "many of them fall far short" of being "self-supporting," one is interested to read on p. 347 of the same issue of *Engineering News-Record* under the caption "The Investor's View of Waterworks Bonds" some of the following statements: (*a*) "The stability of earnings enjoyed by the waterworks business puts water bonds in an enviable position;" and (*b*) "Purchasers . . . recognize the self-supporting character of city water departments and favor water bonds over those issued for general municipal purposes," and (*c*) "It is generally recognized that interest and sinking-fund requirements of municipal water bonds are most usually met out of water revenue." It would seem doubtful to the writer that "specialists in the field of waterworks securities" would be able to report so favorably on municipal waterworks bonds if waterworks were in general not self-supporting, and certainly no such report could emanate from financial sources if Mr. Pirnie's example were typical of municipally operated waterworks.

In the writer's opinion, many loans, otherwise worthy, but which involve taxes in order to be self-liquidating, will not go forward under the present law. Unless the law may be more liberally interpreted, it will need to be amended before these projects may be considered, and in many instances waterworks construction is involved. One of the salutary effects of the law will be, where loans are made, to improve municipal bookkeeping. LEWIS E. AYRES.

Ann Arbor, Mich.,
Sept. 28, 1932.

* * *

Sir—Mr. Louis E. Ayres' letter to you of Sept. 28th has been read with interest. In my original manuscript the example cited of a waterworks history was qualified by the sentence, "Consider a typical although extreme history of a municipal water supply." It was illustrative of some older municipal waterworks in the country largely built at low cost for material and labor and with old rates that have not been changed to meet the higher capital and operating costs during the last twenty years. In my experience I have found a substantial number of municipal waterworks that required support from tax funds in excess of reasonable charges for public fire protection, and many waterworks comparable with the example given by Mr. Ayres. In the latter case, however, the water department has usually been a continuing organization of trained men that functions without material interference from the local government.

The waterworks described by Mr. Ayres clearly should be entitled to a loan for betterments at a low rate of interest from any source. But under the wording of the Emergency Relief and Construction Act a loan from the R.F.C. must be guaranteed by revenues from charges collected "other than by taxation." Undoubtedly there has been a tendency to interpret this to mean that payments by municipalities for water for municipal purposes and for public fire protection constitute payments from charges collected by taxation. This is the principal difficulty to be cleared up in the interpretation of the act in order that many waterworks in excellent financial condition and with standard forms of rates can secure loans from the R.F.C. for needed betterments. It would encourage poor business methods and inequitable charges to force water consumers to pay the entire cost of waterworks services and to furnish free of charge fire protection to all real property in the community and free water for municipal uses. MALCOLM PIRNIE.

New York City,
Oct. 8, 1932.

Shrinkage in Mendota Bridge

Sir—In his report on check levels made on the Fort Snelling-Mendota Bridge (*ENR,* Sept. 29, 1932, p. 371) Mr. Wheeler states that his investigation does not indicate that there has been any deformation due to shrinkage or plastic flow in the concrete during the six years since the completion of the bridge. The writer does not draw the same conclusion from the data presented.

The profiles show the curbs of span 7-8 to average about 0.035 ft. higher on Aug. 29, 1932, than they were on Nov. 4, 1926, with about the same difference at the piers and at the center of the span. Mr. Wheeler states, "As the bridge is about 120 ft. high above the water level, the difference in temperature between Nov. 4, 1926, and Aug. 29, 1932, would account for a rise of about 0.035 ft. at the piers and about the same rise at the center of the span." It is obvious that the rise at the center of the span due to temperature change would be considerably greater than that at the pier because of the bending up of the rib due to lengthening of the arch.

Using a standard formula (*ENR,* Feb. 4, 1926, p. 190), the rise at the span center would be about 0.108 ft., corresponding to a rise of 0.035 ft. at the pier. Therefore, if as Mr. Wheeler concludes, there has been no deformation except that due to temperature change, the center of the span should be about 0.073 ft. higher than shown by the profile. The lowering of the center of the span to the position measured would require a shortening of the arch rib equal to about 0.0003 ft. per foot, which might easily be accounted for by shrinkage and plastic flow.

It should be noted that the centers were struck on Sept. 1, 1926 (*ENR,* March31,1927,p.516), two months and three days before the first profile was run, during which time the shrinkage and plastic flow might be most rapid. It is therefore possible that the shrinkage and plastic flow actually amounted to considerably more than 0.0003 ft. per foot in the reinforced concrete. The amount for plain concrete would be still higher.

Since shrinkage and flow would lower the curbs at the piers as well as at the center of the span, the temperature change does not appear sufficient to account for the difference of about 0.035 ft. in the profiles. The readings were taken with a transit without the use of a target and with turning points 600 to 900 ft. apart, so that great accuracy should not be expected.

The arches of this bridge have a high rise ratio (about $\frac{1}{4}$), and the effect of shrinkage and plastic flow deformation is not as important as in the case of a flat arch. CHARLES S. WHITNEY,

Milwaukee, Wis., Consulting Engineer
Oct. 13, 1932.

Soil Mechanics—a Correction

Sir—The three articles on soil mechanics that appeared in the Aug. 11 issue are such an important contribution to our knowledge of this subject that I desire to call attention to one of the stated conclusions which I believe may lead to errors in design. In describing the effect of a building load on a clay subsoil the article states (p. 161):

> By excavating more soil the settlement can be reduced to any desired amount. An excavation of 27 ft. would lighten the load (due to soil) by exactly the amount of the building load. . . . Consequently there would be no further consolidation on settlement.

An excavation or any disturbance of its natural state causes clay to flow, at varying rates, depending on several factors. Swelling of the clay at the subgrade of an excavation is in part due to the removal of the overburden and in part due to flow under a head, depending on the height of the bank adjoining the excavation.

If it were practicable to maintain a pressure within an excavation equal to the weight of the soil removed, it might be possible to load the soil up to the weight of the overburden existing prior to excavation. The soil at the bottom of an excavation is, however, never in its natural state but is in effect remolded by the work within and by pressure from outside the excavation. Foundation designs for clay subsoils should, until experience warrants otherwise, take the last enumerated factors into consideration. ALFRED BRAHDY,

New York City, Designing Engineer,
Sept. 7, 1932. Board of Transportation.

EDITOR'S NOTE—Re-expansion of clay subsoil upon removal of superincumbent earth load by excavation undoubtedly occurs, as above stated. Its rate is exceedingly slow, however, just as settlement due to compression of clay is very slow, and the effect of re-expansion would require a long time to extend far into the subsoil.

Engineering News-Record

EDITOR—F. E. Schmitt. EDITORIAL STAFF—V. T. Boughton, W. G. Bowerman, F. W. Herring, C. S. Hill, H. W. Richardson, W. W. De Berard, N. A. Bowers, J. I. Ballard.

Editorial and Publishing Offices at 330 West 42d St., New York; 520 North Michigan Ave., Chicago; 883 Mission St., San Francisco; Aldwych House, London, England.

Subscription price $5 per year in the United States; foreign rates on application.

Copyright by McGraw-Hill Publishing Co., Inc.

OCTOBER 27, 1932 Volume 109 Number 17

An Engineering Lifetime

LATE in 1884 a young engineering apprentice, Robert Ridgway by name, began work as leveler on the second Croton aqueduct, the New Aqueduct, as it was known at that time. He remained in New York City engineering service through the boisterous days of the Croton work, the design of the epoch-making first subway just before the turn of the century, and the difficult operations of building the Catskill Aqueduct; and finally he was made responsible for the vast program of building rapid-transit lines which has occupied the city for nearly two decades. This week the same young man, somewhat older in years but a youth in spirit and bearing, retires from the position of chief engineer of the Board of Transportation. His long record of responsible service is a proud mark of engineering attainment; rare indeed is the engineer who achieves a like distinction. But there is something even rarer and higher that makes Robert Ridgway's lifetime of engineering labor a source of inspiration. It lies in the simple fact that he has won and lastingly retained not alone the admiration but the warm affection of all who know him—their spontaneous tribute to his ever-present human kindliness and forbearance and the friendly help which he gave freely to all, small as well as great. Such a reward represents the highest aim to which man may aspire.

New Fields Ahead

AS the attention of the highway field shifts to closer study than heretofore of secondary roads, it is natural that attempts will be made to better the methods of improvement now available for this service. Present developments indicate that these attempts will take three different directions: the improvement of current methods, the revival and improvement of old but neglected practices, and the development of new technique and materials. The recent revival of the old Hassam type of cement-grouted macadam is one example. Another is the introduction of a cement-bound macadam built by new methods, as described in our pages last week. Each of these practices awaits trial under conditions imposed by modern highway transportation. It is certain that improvements in current methods also will be sought when the long-preëmpted field of bitumen-treated types of road is invaded by the new materials and processes. Thus it is apparent that we are on the threshold of a new era in highway building, an era in which secondary road construction will be developed far beyond our present knowledge. Of the new methods and processes that will be tried out, some will be successful, others will probably fail. All of them, however, claim the close scrutiny of highway engineers, in order that the development may progress with greatest directness toward its ultimate objective. Attention to secondary road improvement promises to grow for some time to come, and sure technical knowledge is needed to guide it.

Active Foresight

CURRENT reports from students of business and finance show that advance along many important avenues of business activity is continuing without interruption, and that the country—perhaps also the world as a whole—is steadily climbing upward from the low point of the sag. The advance has evidently gained momentum enough to overcome the inertia arising from that waiting attitude which still holds back much potential enterprise, but it is not rapid, and no sharp acceleration seems likely if present indications are projected forward. Some weeks back it was expected that industry and business would make a sudden bound ahead; the facts of today do not support such beliefs. It is safer to assume that volume will increase only in gradual progression, and that close price, good service and efficiency will remain in control even when the point of unmistakable revival is reached. If this be true, the logical course of action in every walk of life is to prepare with initiative and enterprise for a progressive growth in activity. Only those who thus translate their foresight into action are likely to profit by the advance, since each item of increased demand will go to the men who are prepared for it and seek it.

Make Full Use of Work

THE utmost enterprise in planning is not likely to alter the fact that a difficult time lies directly ahead. Because of the steady growth in unemployment until August the number of idle is still alarmingly high; and a cold winter is forecast. All the knowledge gained from two seasons of dealing with unemployment distress will be needed to temper its rigors. Welfare authorities have long been making ready for the problem; those who are able to provide work for the unemployed in place of welfare relief have also done something, but less energetically. Yet the fact is that work is incomparably more effective than charity as a method of relief; it may be more difficult to apply, but it avoids the stupendous human and economic wastes of the breadline process. Two years of increasing success in applying relief funds through wages earned in useful work have shown the possibilities well enough to warrant public officials and relief groups in setting up this cardinal rule for the coming winter's problems: Maximum relief through work, and minimum relief through charity. Could charity be extended only to those incapacitated for work, and all others be placed in wage-earning employment, the very need for relief might soon shrink to negligible proportions.

The Professional Tie

THOUGH the winter be trying for the unemployed of every degree, the engineer is sure to feel most keenly the needs of his colleagues who through no fault of their own have been deprived of earning power and overtaken by distress. The advancing season calls upon the active sympathy of every member of the profession toward his less fortunate fellows. What was done last winter by the efficient organizations of engineers in the

New York and Boston districts will be continued this year; their campaigns for aid have already begun. With this work as model and inspiration, no doubt the engineers of every community and district will form aid-groups of the same kind, for the human call of sympathy toward co-workers is reinforced by that recognition of professional interdependence which has become strong in recent years. Every instinct admonishes us that relief for engineers is the obligation of the engineering profession first of all. In so far as it discharges this responsibility it will also lessen the burden of general public relief, and thereby promote the wellbeing of the entire commonwealth. We trust that the engineering community will be able to say, when spring returns, that not one of its members was compelled to suffer hardship through the winter; it can then go forward into brighter days in the consciousness of having done its part.

A New Face on an Old Dam

A UNIQUE and effective way of checking the progressive disintegration of a dam is described this week in the review of work recently completed at Ringedal dam in Norway. The old dam, of stone masonry and stone-faced concrete, was built some fifteen years ago, when knowledge of how to make dense concrete was much more limited than at present. Percolation through the dam soon developed, and increased despite attempts to check it by grouting. Finally the expedient of building a thin diaphragm of reinforced concrete in front of the face was adopted in order to free it entirely of contact with water in the reservoir. Struts of reinforced concrete transmit the water load from the diaphragm to the old structure. The mass of the old dam thus continues to resist the water's thrust, but it is freed from the destructive attack of water and from the disruptive effect of frost action on water-soaked masonry. Conceivably a thin facing slab might have been effective, but the separate diaphragm obviously gives more positive assurance.

Timber for Falsework

DESPITE a general similarity in construction operations throughout the country, individual regions often exhibit distinctive characteristics. At times this is due to natural conditions, such as availability of materials or labor, or to climatic factors or more obscure causes. A case in point is the extensive, seemingly lavish, use of timber for falsework purposes in the Pacific Coast area. Beyond the obvious reasons of cheapness and availability there is the more subtle influence of experience and training, which leads construction engineers and contractors of the coast to think and plan in terms of timber for erection methods. A notable example was the unique 300-ft. timber staging used for tower erection on the St. Johns bridge at Portland. Now the same contractor has set a new record of size and utility in the timber traveler used in erecting steel for the Sunnyvale airdock, as described on another page. The very uniqueness of the equipment and method is sufficient to interest those in the field of steel erection. However, behind the mere acquisition of interesting information always lurks the possibility of borrowing and putting to use some new idea. Special construction methods frequently may be transplanted to other regions with fruitful results.

Your Home Town

WASHINGTON doings in matters of R.F.C. construction loans have monopolized attention during many weeks, and for good reason. The painful slowness of the corporation in getting to work on Title II of the Relief Act justly aroused much criticism. The corporation still is slow, but it is doing its best, and *it is making progress.* Can the same be said of your home town?

To start up Relief Act construction of local public improvements so that unemployed men may be restored to work is a bi-partisan undertaking. The local people are the one party; their function is to propose and plan the work, subject to the specifications of the Relief Act. The R.F.C. is the other party; its function is to see that the law's specifications are met and to loan the money. The R.F.C. has no other duty. It is not required, or even empowered, to call on the citizens and officials of Metropolitan City or Piketown and show them what improvements might be undertaken with its funds. That is the sole responsibility of the local citizens and officials themselves. And unless these local people do discover what improvements they need, and do plan them out in detail on sound engineering and financial basis to meet the law's requirements, the Relief Act must fail.

Almost from the first the R.F.C. had before it several hundred projects demanding loans. Many came from private corporations; many were long-current schemes of doubtful or unsound character. Sound projects for state, county, and city improvements were relatively few, and if all of them proved eligible for loans their total would make up only a small fraction of the money provided by Congress in Title II. Nearly two billion dollars of local construction normally required in 1932 has been left undone because of the financial deadlock, but only a small part of this amount has been proposed for R.F.C. loan construction. In consequence, work that might now be providing untold millions of dollars of useful earning power to unemployed men and helping to build up the current of purchasing power and production has not been begun, or even planned or proposed. And this is not the fault of the R.F.C. It is the fault of your home town.

No doubt the unprecedented restrictions of the law created difficulties that seemed insuperable. Not every piece of construction can be made self-liquidating as the law requires. But a great many can be placed on such a basis—bridges and other works that rest on definite service charges or regional benefits, and practically all water improvements and sewage disposal works. The total value of these, counting only the ones that are present necessities, is enough to provide work for large numbers of the local unemployed, and restore sound civic and business conditions.

To date only a few million dollars of R.F.C. construction money have been drawn upon, if the few large projects that will extend over years of work be excluded. The local communities as a whole have not come forward with the construction which they deferred and which now offers the sought-for means of employing the idle. Some few are awakening to the situation and are beginning to act with energy, but they are the exception. Real progress calls for more widespread action, directed with energy and earnest purpose. Not until every local community centers its efforts on starting up all possible R.F.C. construction projects will the Relief Act become truly effective as an instrument of relief and recovery.

NEWS OF THE WEEK

Program Outlined for Road Builders Meeting at Detroit

A TENTATIVE program for the annual convention of the American Road Builders Association to be held in Detroit, Mich., Jan. 16-20, as part of the Highway and Building Congress, has been announced.

Reports of the following general committees will be presented at the convention of the A.R.B.A.: Asphalt, brick and reinforced concrete pavements, single-track concrete pavement, graded aggregate low-cost roads, use of emulsions, equipment for low-cost roads, concrete and corrugated metal pipe, equipment for spreading and finishing, truck scraper blades, snow plows, and hauling equipment for compaction of earth fills.

The county highway officials division will discuss the administrative and financial relationship of the state and county, the relation of the county highway engineer to county highway planning, the importance of technical direction of county highway operations, equipment and plant for county highway maintenance and low-cost bridges.

The city officials division will discuss the conservation of street funds for street purposes, traffic economics, the proper repair of utility opening, low-cost residential streets, the location and design of subsurface street structures, and the standardization of street maintenance records and cost keeping.

Discussions of interest to operators will be the papers on recent state legislation affecting truck transportation, whether trucks pay their rightful share of highway costs, the effect of highway construction on railroad business, why transportation by trucks is a superior service, truck regulation as it relates to the utility of the highways.

Twenty organizations participate

The following twenty organizations have signified their intention to take part in the Highway and Building Congress:

American Road Builders' Association.
Construction League of the United States.
American Society of Municipal Engineers.
Associated General Contractors of America.
International Association of Public Works Officials.
Truck Association Executives of America.
American Motorists Association.
Canadian Good Roads Association.
National Highways Association.
National County Roads Planning Commission.
National Rural Letter Carriers Association.
American Institute of Steel Construction.
Associated Equipment Distributors.
National Crushed Stone Association.
National Paving Brick Association.
National Ready Mixed Concrete Association.
National Sand and Gravel Association.
Portland Cement Association.
Steel Founders Society of America, Inc.
The Asphalt Institute.

A complete program for the congress in which these organizations will participate will be published at a later date.

Traffic Over Hudson River Bridge Falls Short of Estimates

Traffic over the George Washington bridge at the close of its first year of service on Oct. 25 reached a total of a little over 5½ million vehicles and one-half million pedestrians. The preliminary estimates for the traffic of the first year were 8,700,000 vehicles and 1,400,000 pedestrians.

The official statement of the Port of New York Authority states that despite depressed business conditions the structure will earn a net income of $1,200,000 after deducting operating charges and interest on the investment.

The highest monthly traffic record since the bridge was opened was established in August when 602,691 vehicles used the bridge; the busiest day in 1932 was Labor Day when the total reached 37,875. On the opening day the traffic reached a total of 56,456.

◆

Housing to Be Considered at Planning Conference

Future developments in housing, especially as affected by the provisions for financing housing development written into the Emergency Relief and Construction Act in 1932, are to be discussed at the 24th National Conference on City Planning to be held in Pittsburgh Nov. 14-16. Robert D. Kohn, past president, American Institute of Architects, will outline the opportunities that the present movement for large-scale housing development presents to the city planner.

Other subjects for discussion will be a program to prevent economic disintegration of American cities, presented by Harland Bartholomew, president of the conference, making planning more effective, and the way in which sounder planning can contribute to sounder and fairer methods of municipal financing and taxation.

◆

Supreme Court to Consider I.C.C. Railway Valuation Base

Methods used by the Interstate Commerce Commission in fixing a final value on the railroads of the country are again to come before the United States Supreme Court for consideration. The court has agreed to consider an appeal brought by the New York, New Haven & Hartford Railroad Co. from a decision of the Court of Appeals of the District of Columbia in which the court sustained the commission's claim that it should not assign a value to the railroad company's right to participate in the use of the joint terminal facilities used at Boston and New York.

The commission maintains that under the provisions of the valuation act, it is required only to find a "value for rate making purposes," and that in finding such a value it should not include the value of the railroad company's right to use property owned by other railroad companies.

Steel Fabricators Meet To Consider Depression Cures

THE PROBLEMS arising out of almost three years of steadily diminishing business comprised the theme of the tenth annual meeting of the American Institute of Steel Construction held in Pittsburgh, Pa., Oct. 20 and 21 and attended by about 100 persons representing about 75 member organizations. Such subjects as new markets, profitable selling prices, more complete statistics, and better industry cooperation were each considered in the light of the opportunity they offered to increase business and to permit those fabricators who successfully weather the depressions to compete with the lower capital charges of concerns which, in the words of the retiring president, "arise again from the ashes of receivership."

Charles N. Fitts of the New England Structural Co., after four years of service as president, has been succeeded by Clyde G. Conley, of the Mt. Vernon Bridge Co. Other officers elected were first vice-president, Clyde MacCornack, the Phoenix Bridge Co.; second vice-president, H. A. Fitch, Kansas City Structural Steel Co.; treasurer, Robert T. Brooks, The George A. Just Co.; and assistant treasurer, A. J. Post, Post & McCord. The next annual convention of the institute will be held in Chicago.

Speakers were drawn almost entirely from within the industry since they were conceded to have the best and most practical knowledge of conditions and trends. Among the subjects covered were collection and interpertation of the statistics of the fabricated steel industry, marketing problems, the use of steel for housing, and the development of steel floors for buildings and bridges.

Statistics of the industry

In the past the statistics of the fabricated steel industry have been collected and distributed by the U. S. Department of Commerce in the form of weekly and monthly reports. The department has requested the institute to relieve it of this task and upon recommendation of the institute's committee on statistics, this step is to be taken. It is probable that the scope and character of the data can be materially improved and in addition they can be analyzed to much better advantage than was possible previously, according to the committee. The statistical work will fit in well with the proposed plan for stabilization of the steel fabricating industry presented at the convention last year.

Marketing

In his remarks as retiring president, Charles N. Fitts pointed out that during 1932 member plants shipped only about one-third of the business that was being handled a decade ago and only one-sixth of the normal production of recent years, showing the necessity for improved marketing. One aid, according to Mr. Fitts, might be more complete cooperation among members with regard to information on credit and the facts regarding the terms of payment received from purchasers. Mr. Fitts pointed out that institute members could legally disclose the intimate details of their business to one another provided no agreements are made as to prices or preferred customers.

In discussing markets for the future C. G. Conley, Mount Vernon Bridge Co., listed the forces which may continue to cause curtailment of buying of steel for railroads, industrial buildings, office buildings and toll bridges. At the same time he expressed the belief that large tonnages of steel will be required in building elevated highways through congested territory, that narrow bridges will be replaced by wider ones, that airport buildings will require more steel and that many old one- to three-story buildings will have to be replaced.

H. B. Hirsh, Belmont Iron Works, quoted statistics to the effect that of the $60 paid for a ton of structural steel in place, only from $10 to $14 per ton is available for the fabricator. Operating at 50 per cent capacity, depreciation, insurance, taxes, manufacturing costs and selling costs amount to about $12 per ton. Although when running at capacity the charges are only $7 per ton, operation at 25 per cent capacity such as is now the case costs $22 per ton. Mr. Hirsh pointed to the bankruptcies that are sure to follow from such selling prices, and the effects of such bankruptcies on both labor and capital. He urged the establishment of some authority which could administer penalties and punishments for selling below the aggregate of the itemized costs.

Steel for housing

Detailed analysis of systems of steel framing that have been successfully employed, made by F. T. Llewellyn, consulting engineer, U. S. Steel Corp., disclosed the fact that their safe and economical design differs from the conventional methods accepted in tier building design in three respects, namely, (1) from the standpoint of mutual anchorage or support there is greater interdependence between the steel wall framing of a residence and the other materials which envelop the frame; (2) the scope of compression formulas now in use must be extended to greater ratios of slenderness in order to take care of temporary stud conditions during construction; and (3) greater attention to the limits of deflection in floor framing is required. Mr. Llewellyn described the result of the survey which embraced 56 systems of construction classified according to the type of steel members used into six groups as follows: (1) rolled shapes as received from the mill; (2) rolled shapes fabricated into members; (3) sheet or strip formed into members—metal lumber; (4) rolled shapes, sheet or strip fabricated into panel framing units; (5) sheet or strip fabricated into panel filling units; and (6) miscellaneous and foreign. The survey indicated that the potential demand for one and two-family houses in the United States is the equivalent of 300,000 six-room residences per year which if framed of steel, would require 2,250,000 tons of small rolled steel shapes. The survey also showed that the conditions attending the construction of residences have very little in common with those fields wherein multiple production methods are applicable, such as the manufacture and marketing of automobiles. Mr. Llewellyn announced a book that is now being prepared intended for wide distribution containing rules, tables and illustrative examples that will facilitate the design of steel framed houses. T. J. Foster, National Bridge Works, urged steel fabricators to turn their attention to the 97 per cent of apartment buildings in New York which are not built of fireproof construction. Pointing out that it was more difficult to apply steel to single-family residences than to multi-family dwellings, Mr. Foster pointed out that nevertheless more attention is being paid to the former than to the latter. The new markets such as are offered by the apartment house field are what the steel industry needs, according to Mr. Foster, and it also needs to apply to its merchandising as sensible coordination as has been used in its manufacturing work.

Steel floors

The fireproofing, strength and sound conductivity tests being made by the U. S. Bureau of Standards on steel floors were reported to be progressing satisfactorily by F. H. Frankland, director of engineering service of the institute. By the end of November the data collected during the three years' program will be ready to collate, analyze, and incorporate in the final official report of the bureau. Also relating to steel floors were two papers, one by J. H. Young, vice-president, H. H. Robertson Co., in which the Robertson keystone-beam pressed steel floor was described, and the other by J. G. Shryock, Belmont Iron Works, in which the Belmont interlocking floor, made of standard structural steel channels placed alternately up and down, was described.

◆

Rain Ends Threatened Drought in Southeastern States

A progressive decline in the flow of many streams in the Southeastern States which indicated that many new records for low flow would be established this fall, was ended by the Gulf storm which swept across the southern and eastern parts of the country between Oct. 15 and 20. Precipitations as high as 8 in. are reported.

Curtiss-Wright Flying Service

HIGH VIADUCT OVER NEW JERSEY MEADOWS NEARS COMPLETION

A 3-mile diagonal viaduct across the meadows west of Jersey City and across the Hackensack and Passaic rivers which has been under construction by the New Jersey state highway department during the past two years is now nearing completion. It extends from the point where the Holland Tunnel exit road comes out of its depressed passage through the Jersey City heights out to the meadows at a sufficient height to pass over the tracks of the Pennsylvania Railroad and the Hudson & Manhattan line, thence across the meadows, rising to give an under-clearance of 135 ft. at the Hackensack and the Passaic River crossings. It comes down again beyond the Passaic River crossing to join the elevated section of the Lincoln Highway built two or three years ago to bypass Elizabeth and Newark. At present traffic approaching New York over the Lincoln Highway uses the surfaces road at the right of the picture, crossing both rivers on bridges having movable spans. Traffic for the Holland Tunnel turns north soon after crossing the Hackensack River, following a road along the edge of the meadow which cannot be clearly seen in the picture. Manhattan Island is shown at the upper edge of the picture. The Holland Tunnel crosses under the Hudson River at a point a little north of the new pier on the Manhattan waterfront (indicated by a white spot on the photograph). A proposal to charge a toll for use of the viaduct is to be put up to the Bureau of Public Roads by the state for approval.

Two Applications Approved for Funds from R.F.C.

Directors of the Reconstruction Finance Corporation, on Oct. 26, approved a loan of $150,000 to the town of Gulfport, Miss., for a municipal cotton compress and warehouse and a loan of $75,000 to Covington, Ky., for waterworks improvements.

Few new applications to the Reconstruction Finance Corp. for funds have been reported during the past week. The city of Pierre, S. D., has applied for $180,000 for the reconstruction of its gas plant and distribution system.

At Cleveland, Ohio, active interest is reported in a proposal to apply to the R.F.C. for funds to finance the city's $30,000,000 waterworks program. The council is getting ready to advertise $1,200,000 of bonds for this purpose and applications may be made to the R.F.C. for a bid on the bonds. Some time ago a bond issue of $1,500,000 for a new garbage disposal plant was voted but only about one-third of the bonds have been sold. These bonds also may be offered to the Reconstruction Finance Corp. in order to get that work under way.

The Delaware River Bridge Commission has voted to postpone for another month action on a proposed application to the R.F.C. for a loan of $8,000,000 for the construction of a high-speed transit line over the Delaware River bridge at Philadelphia. Reports are current in Philadelphia that the Pennsylvania and the Reading railroads are planning to combine their service from Philadelphia to Atlantic City and if such a combination should be effected, the two lines would probably gain direct access to the city of Philadelphia over the bridge.

The city of Madison, S. D., has decided not to take the loan of $105,000 offered to it by the R.F.C. at 5½ per cent. The interest rate was considered too high.

Fresno, Calif., plans to apply to the R.F.C. for a loan of $225,000 for extension of the storm sewer system of the city.

Early approval of the loan of $75,000,000 to the Port of New York Authority for the proposed 30th St. vehicle tunnel under the Hudson River has been looked for but on Oct. 25 the Board of Estimate of the city voted to ask the R.F.C. to defer action until it could be heard.

◆

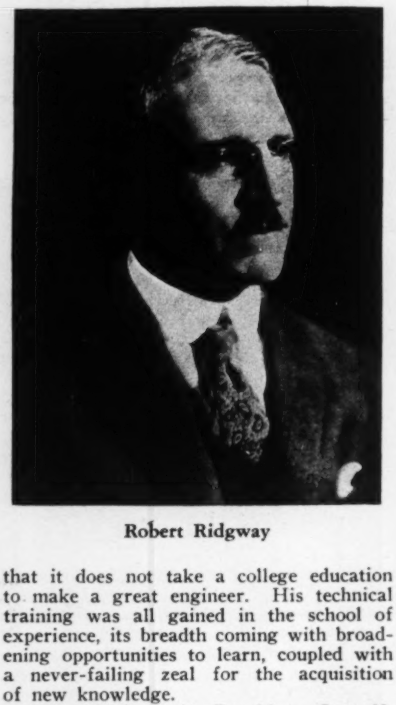
Texas Highway Regulation Again Before Supreme Court

The regulations established by the state of Texas for the use of its highways by a law passed in 1931 are again to be considered by the United States Supreme Court. On Oct. 17 the court announced that it would take jurisdiction in an appeal brought to the court by motor truck operators in Texas to test the validity of the state law as it affects common and contract motor carriers. In May the court upheld the law in so far as it set limitations upon the size and weight of trucks using the highways of the state. The present appeal is from the provisions requiring contract carriers to obtain permits before operating over the highways of the state.

The district court of the United States for the Southern District of Texas has upheld these provisions of the law.

Robert Ridgway Retires from New York Subway Work

Robert Ridgway chief engineer of the Board of Transportation of New York City, is to retire from active service on Nov. 1, having reached the age of 70 years on Oct. 19. Mr. Ridgway's retirement brings to a close a notable record of almost half a century of continuous service to the city of New York. In August, 1884, he began work with the Aqueduct Commission as an instrument man on the "new" aqueduct and dams of the Croton system, the outstanding engineering work of the day; he retires as chief engineer of the city's greatest undertaking, the $648,000,000 independent subway system, as that works nears completion.



Robert Ridgway

Prominent in any review of Mr. Ridgway's career is the re-emphasis of the fact that it does not take a college education to make a great engineer. His technical training was all gained in the school of experience, its breadth coming with broadening opportunities to learn, coupled with a never-failing zeal for the acquisition of new knowledge.

Although born in Brooklyn, Oct. 19, 1862, Robert Ridgway spent much of his boyhood on farms near Dunellen and Cranford, N. J., where he completed his schooling in the common schools and in private study of methematics and the sciences under a local minister who took an interest in his aptitudes.

Railroad work in the West

At the age of 19, hearing that the Northern Pacific was building new lines in the West, young Ridgway left home and went to St. Paul seeking a job. After some disappointments he landed a job with Daniel S. Hastings, on location from Billings to Benton, Mont., some 250 miles. His next job was on location and construction along the south shore of Lake Superior, but after a year that work shut down and he returned to New York and applied for a job on the new Croton aqueduct. The job became available the following August (1884) after he had returned to the Superior construction headquarters.

Returning East Mr. Ridgway began work as a leveler on the aqueduct and the following year he took charge of the northerly end of the aqueduct as an assistant engineer. Subsequently he had charge of construction of the dam and reservoir on the Titicus River, the new gate house of the Croton dam and the Jerome Park reservoir. Political influence was a strong disturbing factor in this work and the resident engineers met almost insuperable difficulties in enforcing good construction.

First subway work

Mr. Ridgway's connection with the aqueduct work continued until 1900, when he became assistant engineer of the second division for the Rapid Transit Railroad Commission. This work included the four-track subway from 41st St. and Park Ave. through 42nd St. to Broadway and north under Broadway to 104th St. In March, 1903, he was appointed division engineer of the fifth division, which included work at the lower end of Manhattan Island and in Brooklyn, also the Battery-Joralemon St. tunnels, the first pair of rapid-transit tunnels to be constructed under the East River.

In 1905 Mr. Ridgway returned to water supply work with the newly-created Board of Water Supply, as a division engineer on studies for the projected Catskill system. In the spring of 1906 he was promoted to the position of department engineer and placed in charge of construction of the Northern Aqueduct Department, including the northerly 60 miles of the Catskill aqueduct. This work included the siphon crossing under the Hudson River at a depth of over 1,000 ft. He remained on the aqueduct construction until its practical completion in 1912.

Mr. Ridgway again returned to subway work in January, 1912, as engineer of subway construction for the Public Service Commission, the body then in charge of the supervision of construction of the new rapid-transit subways and elevated lines in New York City, including five tunnels under the East and Harlem rivers. He continued in this position until May, 1921, when he was appointed chief engineer of the Transit Commission, a body which succeeded the Public Service Commission. In 1924, when the Board of Transportation of the City of New York was organized to take over the planning and construction of the city's independent subway system, he was appointed chief engineer, and has continued in that position until now.

Consulted on Chicago subways

Mr. Ridgway has been intrusted with many responsible charges outside the New York work. In 1916, with William Barclay Parsons and Bion J. Arnold, he served as a member of the Chicago Traction and Subway Commission to report on transit conditions in that city. Again in 1930 he was made chief consulting engineer on the projected Chicago subway. In recent years he has been called in on numerous large undertakings in a consulting capacity, notable among them being the Hoover Dam board of advisory engineers (Sibert board) and the board of engineers for the Trans-Bay Bridge at San Francisco.

Mr. Ridgway has always taken an active part in technical society affairs. He has served the American Society of Civil Engineers as director, vice-president and, in 1925, as president.

Personal Notes

William B. Short, former city engineer of Anacortes, Washington, has been named superintendent of the water department of that city to succeed William Burke, resigned.

Max C. Tyler, lieutenant colonel, Corps of Engineers, has been appointed district engineer at Buffalo, N. Y. He succeeds Major **Eugene Reybold**, who was transferred to Washington, as noted last week. Colonel Tyler has been serving as district engineer of the First Mississippi River District. Major **Henry Hutchins, Jr.**, assistant to the district engineer, Galveston, Texas, has been appointed district engineer, First Mississippi River District, vice Lieut.-Col. Max C. Tyler.

George C. Ward, vice-president in charge of construction, Southern California Edison Co., was elected president of the company at the board meeting on Oct. 18 to fill the vacancy caused by the death of the former president, R. H. Ballard. Mr. Ward is a native of White Plains, N. Y., a graduate of Phillips Academy at Andover, Mass. He began active work in 1881 as a chairman with the North River Construction Co. on the construction of the West Shore Railroad. Upon completion he entered the operating department of the railroad as a resident engineer. Subsequently he was an assistant engineer on the New York State canal and then was engaged in water supply work. In 1911 Mr. Ward was appointed executive in charge of all engineering and construction work on the Big Creek-San Joaquin development of the Southern California Edison Co.

Melville Dozier, Jr., is returning to consulting practice after serving as manager of the Southern California Chapter and California State Branch, Associated General Contractors, at Los Angeles for seven years. From 1918-1923 Mr. Dozier was general manager and chief engineer for the state reclamation board, in charge of state flood control and reclamation work. During this period he represented the state in conferences with Arizona on Colorado River matters. Prior to that he had been in private practice both as an engineer and a contractor. At one time he was manager, Construction Industries Council of Southern California representing the industry in legislative and public interest matters.

◆

Obituary

Frederick J. Munn, general contractor of Buffalo, N. Y., died there on Oct. 17, age 60 years.

Frank B. Byrnes, superintendent of construction of the Dallas District of the Texas Oil Co., died at his home in Dallas on Oct. 15, age 48 years.

Harrison W. Hayward, professor of materials engineering at Massachusetts Institute of Technology, died at Cambridge, Mass., Oct. 18. Professor Hayward was a graduate of the institute in the class of '96 and had served on its teaching staff almost continuously since that time, becoming professor of materials engineering in 1920. In recent years he has practiced extensively as a consultant on engineering materials.

SOCIETY CALENDAR

AMERICAN ASSOCIATION OF STATE HIGHWAY OFFICIALS, annual meeting, Washington, D. C., Nov. 14-18.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, Detroit, Mich., Jan. 16-18.

AMERICAN PUBLIC HEALTH ASSOCIATION, annual meeting, Washington, D. C., Oct. 24-27.

AMERICAN ROAD BUILDERS ASSOCIATION, annual convention and road show, Detroit, Mich., Jan. 16-20.

AMERICAN SOCIETY OF CIVIL ENGINEERS, annual meeting, New York, N. Y., Jan. 18-21.

AMERICAN SOCIETY OF MUNICIPAL ENGINEERS, annual meeting, Detroit, Mich., Jan. 16-20.

ASPHALT INSTITUTE, Asphalt Paving Conference, New Orleans, La., Dec. 5-9.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, annual convention, Detroit, Mich., Jan. 16-18.

HIGHWAY RESEARCH BOARD, National Research Council, Washington, D. C., Dec. 1-2.

HIGHWAY AND BUILDING CONGRESS participated in by twenty national engineering societies and trade associations, Detroit, Mich., Jan. 16-20.

INTERNATIONAL ASSOCIATION OF PUBLIC WORKS OFFICIALS, Detroit, Mich., Jan. 16-18.

ENGINEERING INSTITUTE OF CANADA, annual meeting, Ottawa, Ont., Feb. 7-8.

NATIONAL ASSOCIATION OF RAILROAD AND UTILITIES COMMISSIONERS, annual meeting, Hot Springs, Ark., Nov. 15-18.

NATIONAL CONFERENCE ON CITY PLANNING, annual meeting, Pittsburgh, Pa., Nov. 14-16.

NATIONAL CRUSHED STONE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 16-18.

NATIONAL PAVING BRICK ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

NATIONAL READY MIXED CONCRETE ASSOCIATION, annual meeting, Detroit, Mich., Jan. 18.

NATIONAL SAND & GRAVEL ASSOCIATION, annual meeting, Detroit, Mich., Jan. 17-18.

PORTLAND CEMENT ASSOCIATION, Detroit, Mich., Jan. 16-18.

VIRGINIA WATER AND SEWAGE WORKS ASSOCIATION will hold its fourth annual meeting at Staunton, Va., Nov. 14-15.

NATIONAL RIVERS AND HARBORS CONGRESS will hold its annual convention in Washington, D. C., Jan. 17-18. This is a change from the normal meeting date in December.

IOWA TREATMENT CONFERENCE and IOWA WASTES DISPOSAL ASSOCIATION will hold a joint meeting Nov. 3-5 at Iowa State College, Ames. Topics scheduled include government finance for sewage works, utilization of natural stream purification, use of sewage gas to burn garbage, inhibiting sewage odor with chlorine, effect of industrial wastes on sewage works operation, creamery and corn wastes, control technique, operation during the depression and diffuser mediums.

SOUTHWESTERN WATER WORKS ASSOCIATION held its annual meeting in Fort Worth, Texas., Oct. 10-13. About 200 members attended. The work of the Tarrant County Water Control and Improvement District No. 1 was included in the technical discussion. Divergent views as to the advantages of R.F.C. loans for waterworks development were expressed at the meeting. Edwin A. Fowler, New Orleans, expressed the view that overbuilding of waterworks might develop from the use of government funds in their construction as a relief measure.

METROPOLITAN SECTION, AMERICAN SOCIETY OF CIVIL ENGINEERS, at a meeting held on Oct. 19, considered the new union inland freight terminal and commerce building of the Port of New York Authority. Eight railroads entering the New York metropolitan area will use the basement and ground floor of the terminal for the interchange of freight between shipper trucks and trucks of the railroad companies used for the transfer of consolidated shipments from the terminal to the rail terminal in New Jersey. John C. Evans, terminal engineer, of the Port Authority, was the principal speaker. Discussion was by P. L. Gerhardt, industrial consultant, C. W. Rau, agent for the railroads operating the terminal and J. A. Hoffman, vice-president of the Motor Haulage Corporation.

MISSOURI WATER AND SEWERAGE CONFERENCE met Oct. 13-14 at Sedalia. Subjects covered included the following for water: When and how to wash a filter, softening, iron removal, operators' problems, laboratory control, chemical treatment, water rates, R.F.C. loans, complaints, billing methods, meter tests, fire hydrant inspection, copper services, painting standpipes, reservoir repairs, cross-connections, and pump economies. For sewage, topics were as follows: Recent developments, laboratory control, gas for heating, sludge, sewer rental charges, treatment needed, jointing materials, chlorination, power costs. Officers elected for the ensuing year are as follows: Chairman, W. E. Barnes, Liberty; vice-chairman, L. P. Andrews, Sedalia; secretary-treasurer, Herbert Bosch, State Board of Health, Jefferson City.

Arthur L. Davis, Executive of Bridge Company, Dies

Arthur L. Davis, vice-president and general manager of sales of the American Bridge Co., died at Atlantic City on Oct. 19, 1932, at the age of 66. He had been engaged in the structural steel industry for 43 years and had been an active figure in its development from the modest proportions of the 80's to the present time.

Born in San Francisco Aug. 17, 1866, Mr. Davis soon after graduating from the Massachusetts Institute of Technology in 1889 entered the employ of the Central Vermont Ry., and later of the Vermont Construction Co. In 1898 he became assistant to the general sales manager of the Berlin Iron Bridge Co., and two years later, when this company became a part of the American Bridge Co., he became assistant to the president of the American Bridge Co. of New York. In 1911 he was appointed division contracting manager, in 1927 general manager of sales, and in 1931 vice-president and general contracting manager. He negotiated many of the principal construction contracts undertaken by the company. Mr. Davis was a man of exceptionally high ideals. His unquestioned dependability and integrity commanded high respect throughout the steel world and his fine personality won him the affection of his associates and those with whom he was brought in contact.

◆

Seek to Delay Construction of Union Station in Los Angeles

The Southern Pacific, the Atchison, Topeka & Santa Fe, and the Los Angeles & Salt Lake railroad companies have petitioned the Railroad Commission of California to permit them to defer construction of the proposed union passenger station in Los Angeles. The commission, in 1927, ordered the construction of a union station but work has been held up. Recently, because the railroad companies could not agree as to distribution of the cost among themselves, the commission set a date upon which it would determine the distribution if the railroads did not come to an agreement.

Important Food Control Unit on Mississippi Nears Completion

The New Madrid-Birds Point floodway of the Mississippi flood control system is now 98 per cent completed with only minor work remaining to be done on the levees.

Cutting down the levees at the north end of the floodway to make the proposed "fuse plug" levee to admit water to the floodway from the main river after it reaches a predetermined height will not be undertaken until litigation over the use of the floodway is settled.

Hearings in the suit to determine how much the government shall pay for flowage rights in the floodway were begun on Oct. 18 before a federal court sitting at Cape Girardeau, Mo.

Proposed New Railroad Line Across Pennsylvania Rejected

A proposal for the construction of a 283-mile railway line across Pennsylvania between Easton and Pittsburgh which has been before the Interstate Commerce Commission since early in 1925 (*ENR*, June 25, 1925, p. 1076) finally was denied by the Interstate Commerce Commission on Oct. 20. The proposal, put forward by the New York, Pittsburgh and Chicago Railroad Co., was one favored by the late E. H. Harriman for the formation of a new railway line from New York to Chicago. In the negotiations before the Interstate Commerce Commission L. F. Loree, veteran engineer and president of the Delaware & Hudson Co., has represented the Harriman estate.

The project was first put forward about 1904 and in 1914 the line was located from Pittsburgh as far east as the Susquehanna River. It was to be a double track line having an 0.3 per cent grade against eastbound traffic and an 0.4 grade for westbound traffic except for a 7½ mile pusher grade of 1⅜ miles. Using the Lehigh Valley from New York to Easton, the new line from Easton to Pittsburgh and the Wabash west of Pittsburgh, it was proposed to create an additional line from New York to Chicago about 80 miles shorter than the Pennsylvania R.R. line, now the shortest, and having very favorable grades.

In denying the application, the commission said, "It is clear that neither present nor future public convenience and necessity have been shown, or can now be shown, to require construction of this new line."

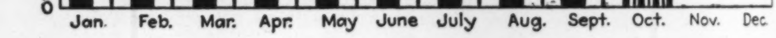
Engineering Contracts and Capital

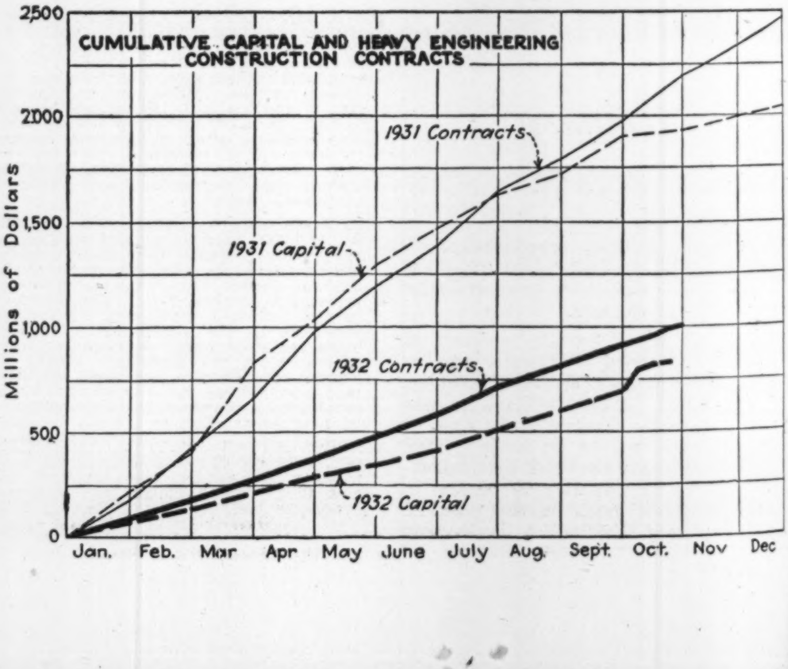
HEAVY CONSTRUCTION contracts reported for the past week total $24,347,000, 10 millions below the awards of the previous week, but equal to the average weekly lettings for the month of October. The average weekly contracts for this month are above those for the past two months, and are surpassed only by May and July. Streets and road contracts for the week amounted to $7,900,000, a considerable drop from the 12 to 15 million-dollar weeks reported for this class of work since early in September. Federal awards reached $8,900,000, much stronger than the average weekly amount. Private contracts were low as usual, totaling $3,700,000. Large contracts reported include highways, Montana, $938,000; highways, Nebraska, $922,000; levees, Missouri River, $2,827,000; levees, Mississippi River, $2,000,000; and two post offices, Jacksonville, $1,211,000 and Albany, $1,291,000.

Bids have been called for on a federal hospital at Philadelphia, estimated at $2,250,000, and a post office at Nashville, $1,563,000. Large proposed projects include an oil pipeline, Lander, Wyo., estimated at 1½ millions and a post office at St. Louis, to cost $4,250,000. The American Telephone & Telegraph Co. announced plant extensions and improvements to cost 35 millions, the work to be done through subsidiary companies by separate contracts and day labor. The character of the work has not been announced.

Few new capital issues were reported last week, the total amounting to $4,700,000. No private issues were sold, and the Reconstruction Finance Corp. reported no self-liquidating loans.

In the construction materials field, interest centered around the reduction of the price of steel rails from $43 per ton to $40. The price had remained unchanged since October, 1932. No price changes were made in other steel products. Structural shapes are quoted at $34.00 at Pittsburgh and $36.00 at Chicago.





Contracts and Capital

CONSTRUCTION

(Thousands of Dollars)

	Weekly Average Oct., 1931	Weekly Average Oct., 1932	Week Oct. 27, 1932
Federal government..	$ 4,705	$ 6,263	$ 8,927
State and municipal..	21,823	13,700	11,742
Total public.......	$26,528	$19,963	$20,669
Total private......	29,765	5,240	3,678
Week's total.......	$56,293	$25,203	$24,347
Cumulative, Jan. 1 to date:			
1931 construction....................			$2,190,287
1932..............................			1,015,506

Decrease, 53 per cent.

NEW PRODUCTIVE CAPITAL

(Thousands of Dollars)

	Weekly Average Oct., 1931	Weekly Average Oct., 1932	Week Oct. 22, 1932
R.F.C. loans.........	....	$23,800	....
New capital issues....	$6,200	10,400	$4,700
Total.............	$6,200	$34,200	$4,700
Cumulative, Jan. 1 to date:			
1931 new capital......................			$1,918,600
1932 R.F.C. loans...........		$124,500	
1932 new capital............		707,400	
1932 total...........................			$831,900

Decrease, 57 per cent.

ENR Cost and Volume Index

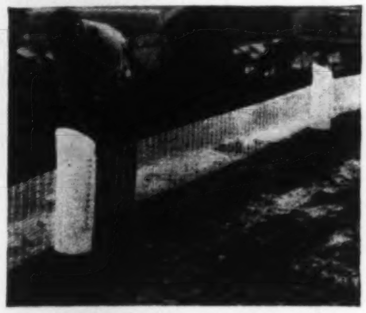
Cost		Volume	
October, 1932..	159.16	**Sept., 1932**.......	124
September, 1932	157.96	August, 1932......	111
October, 1931...	169.78	Sept., 1931........	225
1931 (Average).	181.35	1931 (Average)....	220
1930 (Average).	202.85	1930 (Average)....	260

1913 Average......... 100.00

Construction Equipment and Materials

Woven Wire Highway Guard of High Strength and Resiliency

A new style of woven wire highway guard fence, known as the Pittsburgh Safety Highway Guard, designed to afford utmost safety to both car and occupants, has been developed by the Pittsburgh Steel Co., Pittsburgh, after four years of research and tests. The manufacturers have endeavored to provide more than a mere barrier, and claim to have a guard of unusually high strength and resiliency that will ease the impact shock of a striking car and turn the vehicle back into the road without hitting the posts. The guard is a 14-in. band, woven under tension in 500-ft. lengths from an alloy steel wire of high tensile strength, with an elastic limit equal to 95 per cent of its ultimate strength.



Pittsburgh Safety Highway Guard of high-strength woven wire.

Under test the band developed a breaking strength of over 100,000 lb. The high strength is developed by the main or longitudinal wires running parallel to each other continuously throughout the length of the band. The method of fabricating the high elastic limit wire gives the guard its resiliency. The guard is erected on low posts, preferably spaced 14 ft. center to center, at a height that will catch the hubs and bumpers of a vehicle. Clamps fastening the band to the post are designed to allow free movement of the guard with resulting distribution of shock. The fabric is heavily galvanized, allowing it to be easily seen, or it may be painted white to provide further visibility. It is erected with ordinary fence-stretching tools at a total cost said to compare with other types of guard in common use.

◆

High-Capacity Welding Machine

The new "Shield Arc" welder, rated at 40 volts, is announced by the Lincoln Electric Co., Cleveland, Ohio. A uniform welding current is one of the features claimed for the new machine. By leveling the hills and valleys or the rapid fluctuations of the usual welding current, the "Shield-Arc" is claimed to allow the use of a higher average current per given sized rod which permits a considerable increase in the speed of welding and the amount of weld metal deposited. The rating of 40 volts is desirable for use with the shielded arc electrodes recently developed by the same company. The design of the machine is such as to eliminate the necessity for a stabilizer or kick transformer. The new welder is also equipped with dual control, permitting independent regulation of current and voltage.

LINCOLN WELDER

Lincoln Electric Co.'s new welder

The new "Shield-Arc" welders are built in alternating current and direct current motor driven types of 300, 400 and 600 ampere sizes. Removable running gear and draw bar facilitate a change from portable to stationary model. The manufacturer reports that technical bulletins on the new machine are available.

◆

New Publications

Diesel-Electric Car. The Westinghouse diesel-electric rail car is described in a new four-page folder (D.M.F. 5425) issued by the Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa. Photographs show both the complete cars and the oil-engine generator sets, and drawings illustrate how the engine compartments are arranged. A tabulation lists the Westinghouse diesel-electric equipments in service and the duty they have performed.

Electric Locomotives. Atlas electric locomotives are comprehensively described in the 96-page catalog, No. 1245, published by the Atlas Car & Manufacturing Co., Cleveland, Ohio. The catalog lists electric locomotives under three general headings: storage battery, combination and trolley locomotives. The individual machines, as illustrated, are gathered under separate headings according to their service applications, such as coal mining, metal mining, tunnel service, load carrying, industrial and switching locomotives.

Expansion Joints. Packless expansion joints, known as FlexoDisc, are described in detail in a new illustrated bulletin of 8 pages published by the Croll-Reynolds Engineering Co., Inc., 17 John St., New York, N. Y. The joint is suitable for handling expansion in steam mains, miscellaneous piping and for special expansion problems and is available in sizes from 3 in. to 30 in. The expansion element is of alloy steel.

Road Roller. The Austin Cadet road roller is described in a 20-page booklet issued by the Austin-Western Road Machinery Co., 400 North Michigan Ave., Chicago, Ill. This is a new model patterned after the Austin double spur gear drive Autocract. The new roller comes in 5, 6, 7 and 8 ton sizes.

Steel Sheets. The American Sheet & Tin Plate Co., Pittsburgh, Pa., has issued a 24-page bulletin entitled "Steel Sheets Applied to Modern Construction." The booklet gives special attention to heating, ventilating and air conditioning systems and general sheet metal work. It is illustrated with photographs of a number of representative applications.

New Equipment in Brief

Steam Pumps. An improved line of horizontal duplex steam pumps, especially designed and fitted for handling either water or chemical solutions, recently has been announced by the Worthington Pump & Machinery Corp., Harrison, N. J. The pumps are built in three different types—valve plate, turret and pot valve. One of the new features is the adoption of stainless-steel drop-forged valve service on all models.

Excavators. Bucyrus-Erie Co., South Milwaukee, Wis., has announced a new ½ yd. excavator, known as the 16-B. Its weight is less than 30,000 lb. and it is equipped with a 6-cylinder gasoline engine to develop 54 hp. Among the new features are conical swing rollers, elimination of dead weight, no dead counterweight, chain-crowd with high speed retraction, single-shaft-drive mounting and all welded box girder boom and outside sticks.

Stump Puller. The P & H Stump Puller is announced by the Harnischfeger Corp., Milwaukee, Wis. The puller is operated in connection with a crane or dragline. The puller is reeved up and operated much like a dragline bucket. The operation of pulling the stump begins by hauling in the drag cable which pulls the arms together until their knife edges are imbedded in the stump. A continued pull on the drag cable pulls the stump from the ground. The equipment is made of heavy alloy steel throughout.

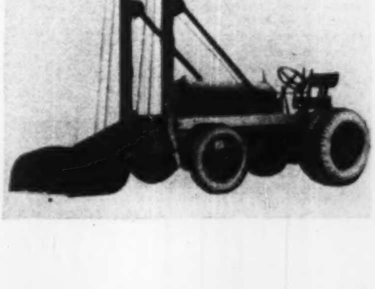
◆

Light Loading Machine Has High Lift and Long Reach

The Fabriform loader for operation with McCormick-Deering industrial tractors has been introduced by the Industrial Equipment Division of the Pettibone Mulliken Co., 4710 West Division St., Chicago, Ill. The new loader is light in weight and is constructed so that the operator has an unobstructed view, both ahead and to the rear. The loader is mounted on the McCormick-Deering industrial tractor and is applicable to road building, railroads, building construction, municipal, public utility, airport, snow removal and similar work where heavy and bulky materials are handled.

The manufacturer calls attention to the high-lift and long-loading-reach features. It has a loading height of 8½ ft. and will load any 2-ton truck entirely from the rear. The loader bucket is ½-yd. capacity and has a traveling speed of 68 ft. per minute.

Fabriform loader by Pettibone Mulliken



Current Construction Unit Prices

Close Bidding on Sewerage Plant, Alabama

AN UNUSUALLY narrow spread of bids was received Sept. 2 for the construction of the Ensley sewage treatment plant for Jefferson County, Alabama, thirteen proposals ranging from $155,612 to $176,738, a difference of $21,126 between high and low bids. There was a difference of only $173 between low and second proposals, and $762 between second and third. The plant was designed by H. H. Hendon, sanitary engineer for the County Commission, to handle 15 m.g.d. domestic sewage. Fuller & McClintock reviewed the plans.

Following is a list of all bidders with total bids. Four contractors offered to deduct $2,000 from their bids if all Dorr equipment was permitted. Contract was let on this basis to Christie, Hutchinson & Burton, Birmingham, for $155,612. Unit prices of principal items are also given for the two low bidders, miscellaneous small items not being shown.

Complete list of bidders

Bidders	Total Bid
1. Christie, Hutchinson & Burton	$157,612
Same, all Dorr equipment*	155,612
2. Southern Construction Co	157,785
Same, all Dorr equipment	155,785
3. The McClelland Co	158,547
Same, all Dorr equipment	156,547
4. W. L. Coston & Sons	156,685
5. Southern Ferro-Concrete Co	157,489
6. Smith-Pew Const. Co	165,925
7. H. G. Cristman-Burke Co	165,993
8. W. L. Hailey & Co	166,604
9. The J. B. McCrary Co	166,692
10. W. C. Howton Contracting Co	170,350
Same, all Dorr equipment	168,350
11. Fiske-Carter Constructing Co	175,812
12. A. K. Adams & Co	175,520
13. Day & Sachs	176,738

* Contract.

Detailed unit prices

Principal Items	Quan.	Unit Prices Bidder No. 1	Unit Prices Bidder No. 2
Earth excavation, cu.yd	10,000	$0.23	$0.20
Rock excavation, cu.yd	5,000	1.15	1.25
Reinforcing steel, lb	405,000	.0267	.025
Concrete, class A, cu.yd	2,700	10.00	9.93
Concrete, class B, cu.yd	450	9.35	6.00
2-in. grout, sq.yd	1,620	.60	.66
Rubbed finish, sq.ft	5,000	.02	.03
Copper plate expansion joint, lin.ft	480	.36	.58
Mastic expansion joint, sq.ft	250	.215	.139
Asphaltic expansion joint, lin.ft	750	.02	.175
Cast iron pipe, b.&s., 12 ft., lb	75,000	.032	.0263
Ditto, less than 12 ft. long, lb	2,000	.043	.0373
Cast iron pipe flanged, 12 ft., lb	12,000	.04	.045
Ditto, less than 12 ft. long, lb	2,000	.086	.1026
Cast iron specials, b.&s., lb	7,000	.077	.0676
Cast iron specials, flanged, lb	5,000	.09	.089
Galv. iron pipe, 1 in., lin.ft	2,500	.15	.121
Galv. iron pipe, 3 in., lin.ft	3,000	.64	.491
Condensation traps, 3 complete	....	150.00	139.45
Pressure relief tanks, 2 complete	....	145.00	93.00
Expansion tank	1	33.50	186.00
Sewage meter complete	1	2,673.00	2,650.00
Gas meters, 5 complete	....	735.00	860.00
Clarifier mechanisms	2	12,250.00	11,925.00
Digestor mechanisms	2	12,650.00	11,940.00
Detritor mechanism	1	6,250.00	6,030.00
Automatic bar screen mechanism	1	2,500.00	2,340.00
Slag, ¾-in. to 1½-in., cu.yd	850	1.70	1.96
Slag, 1½-in. to 2½-in., cu.yd	1,275	1.60	1.96
Filter sand, cu.yd	850	2.00	2.90
Drain tile, sludge drying beds, l.f.	6,500	.05	.06
Industrial track, 24-in. ga., l.f.	3,360	.58	.75
Turn tables for industrial track	27	65.00	53.45
Switches for industrial track	27	25.00	50.00
Cars for industrial railroad	6	82.00	93.00
Screen house, complete	1	2,750.00	3,087.0
Pump house, complete	1	2,210.00	2,234.0
Digestor heating boiler	1	1,025.00	773.00
Sludge pumps, plunger type	2	1,200.00	1,130.00
Drain tile, 4-in., lin.ft	2,400	.07	.11
Manholes, complete	14	47.00	45.40
Incinerator, complete	1	3,340.00	3,186.00
Grease skimming tank	1	90.00	70.00
Main Switchboard and distribution panel	1	890.00	890.00
Lighting standards	10	53.50	70.00
Dry chemical feeder	1	406.00	545.00
Gas holder	1	1,850.00	3,325.00
Total		$157,612	$157,785
Total, using all Dorr equipment		$155,612	$155,785

Hydroplane Ramp, Lake Pontchartrain

THE BOARD of Levee Commissioners, Orleans Levee District, New Orleans, is building a hydroplane ramp on the shore of Lake Pontchartrain adjacent to the Shushan Airport. The ramp is of reinforced concrete, 80 ft. wide and 207 ft. long, carried by 16-in. square reinforced concrete piles 16 to 34 ft. long. The deck is an 8-in. reinforced concrete slab supported on concrete stringers, which are, in turn, carried by concrete girders framing into the pile caps. All the concrete work is poured monolithically. Over the deck slab a creosoted wood decking is placed and fastened to wooden nailers which are fastened to the concrete deck with brass inserts and bolts. Most of the deck structure is being built within a cofferdam, as half of the ramp is submerged by the average lake tide. Bids were taken on a lump-sum basis, the contractor stating number of days allowed for completion. A penalty of $50 per day will be charged for each day taken beyond time specified by contractor, and $50 per day bonus will be paid for completion under time specified. Contract was let late in July to second low bidder, W. Horace Williams Co., for $40,500 net.

Following are items and quantities and list of bidders. John Klorer is chief engineer of the Orleans Levee Board.

Item	Quantity
Reinf. concrete piles, 16 to 34 ft	103
Concrete in piles, cu.yd	203
Concrete in slab, beams etc., cu.yd	666
Reinforcing in piles, tons	26
Reinforcing in slab, beams etc., tons	79
Brass inserts	1,040
Brass bolts, ½x5½ in.	1,040
Brass washers, ½ in.	2,080
Galvanized boat spikes, 5 in., lb	1,300
Creosoted pine decking, M ft. b.m.	44.5
Creosoted pine nailers, M ft. b.m.	5.6
Rubber expansion joint filler, lin.ft	80

Bids Received:

Contractor	Days	Net Bid	Bid Corr. for Time
Gervais F. Favrot	88	$38,330	$38,330
W. Horace Williams Co. (Contract)	75	45,500	39,850
Doullut & Ewin	120	39,788	41,388
W. D. Stewart	90	44,560	44,660
Caldwell Bros. & Hart	90	45,000	45,100
Dalgarn Const Co	150	52,459	55,559

◆

Effect of Labor Rates on Bridge Bid

BIDS SUBMITTED for the construction of a 200-ft. span concrete arch bridge for the city of Ft. Scott, Kan., show the effect of common labor rates on the cost of work of this class. One contractor, Vance & Son, Parsons, Kan., submitted two bids, one based on 30c. per hour for common labor, the other based on a 25-cent rate. These bids totaled $43,445 and $42,993, respectively. Thus a 16.67 per cent drop in the common wage scale reduced the total cost of the job only 1.04 per cent. Contract was let to J. H. Johnson, Dallas, Tex., for $39,800, no common labor rates being specified in the bid tabulations.

The bridge carries a 30-ft. roadway and two 5-ft. sidewalks. Marsh Engineering Co., Des Moines, is consulting engineer. Fred Hawthorne is city engineer. Following are unit prices on main items in bids submitted by (A) J. H. Johnson, contract; (B) Vance & Son, 30-cent labor rate; (C) Vance & Son, 25-cent labor rate. Bids include 5 per cent for engineering fees.

Item	Quantity	Unit Prices (A)	Unit Prices (B)	Unit Prices (C)
Concrete, class AA, cu.yd	234	$15.00	$15.00	$14.85
Concrete, class A, cu.yd	1,174	13.90	15.75	15.60
Concrete, class D, cu.yd	59	14.70	25.00	25.00
Reinforcing, lb	133,284	.036	.032	.031
Structural steel, lb	83,986	.09	.058	.058
Excavation, dry, cu.yd	1,654	.70	2.25	2.18
Excavation, wet, cu.yd	578	4.00	4.50	4.30
Excavation, rock, cu.yd	27	3.00	6.00	5.65
Grouted riprap, sq.yd	250	1.75	2.50	2.50
Earth grading, cu.yd	460	.25	.35	.35
Brick paving, relayed, sq.yd	1,065	.85	2.00	2.00
Removing old structure	.....	500.00	500.00	500.00
Total		$39,800	$43,445	$42,99